

Authentic Literacy in Career and Technical Education:
Technical Appendices to the Spring 2009 Pilot Study

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Technical Appendix A: Research Questions and Hypotheses

The purpose of this research study was to determine the impact of disciplinary literacy strategies on the reading comprehension and motivation to read for students enrolled in CTE courses. The objective was to compare the effects of literacy strategy instruction under a control condition and two models of content area reading interventions: a CTE framework and the MAX Teaching Framework. The project thus answered the following research questions:

1. Do students in the intervention groups score differently (higher) than students in the control condition on reading comprehension, vocabulary, and motivation to read?
2. What are students' perceptions of reading and reading strategy use in CTE?
3. How do CTE teachers adapt their teaching practice to include explicit, embedded scaffolding of reading and use of literacy strategies?

The following hypotheses were tested:

- 1) H^0_{1a} : There will be no statistically significant difference in the gain scores for total reading scores, as measured by the Gates-MacGinitie Reading Test (GMRT; MacGinitie, MacGinitie, Maria, Dreyer, & Hughes, 2006) of students in the MAX Teaching group compared to the control group.
- 2) H^0_{1b} : There will be no statistically significant difference in the gain scores for total GMRT scores of students in the CTE Reading group compared to the control group.
- 3) H^0_{1c} : There will be no statistically significant difference in the gain scores for total GMRT scores of students in the MAX Teaching group compared to the CTE Reading group.
- 4) H^0_{2a} : There will be no statistically significant difference in the gain scores for GMRT vocabulary of students in the MAX Teaching group compared to the control group.
- 5) H^0_{2b} : There will be no statistically significant difference in the gain scores for GMRT vocabulary of students in the CTE Reading group compared to the control group.
- 6) H^0_{2c} : There will be no statistically significant difference in the gain scores for GMRT vocabulary of students in the MAX Teaching group compared to the CTE Reading group.
- 7) H^0_{3a} : There will be no statistically significant difference in the gain scores for GMRT comprehension of students in the MAX Teaching group compared to the control group.
- 8) H^0_{3b} : There will be no statistically significant difference in the gain scores for GMRT comprehension of students in the CTE Reading group compared to the control group.
- 9) H^0_{3c} : There will be no statistically significant difference in the gain scores for GMRT comprehension of students in the MAX Teaching group compared to the CTE Reading group.
- 10) H^0_{4a} : There will be no statistically significant difference in the motivation gain scores, as measured by the Motivations for Reading Questionnaire (MRQ; Wigfield & Guthrie, 1997, 2004) of students in the MAX Teaching group compared to the control group.
- 11) H^0_{4b} : There will be no statistically significant difference in the gain scores for MRQ of students in the CTE Reading group compared to the control group.
- 12) H^0_{4c} : There will be no statistically significant difference in the gain scores for MRQ of students in the MAX Teaching group compared to the CTE Reading group.

Technical Appendix B: Methods

Within this pilot study, an experimental design was used with intact groups of students and teachers, randomization of class treatments, and pre- and posttesting (Ary, Jacobs, & Razavieh, 2002; Gall, Gall, & Borg, 2003). Teachers were randomly assigned to the treatment and control groups. The purpose was to determine the causal relationships between the variables of interest: two reading framework treatments (X_1 and X_2) and control (X_3) groups:

Treatment ¹	O ₁	X ₁ . MAX Teaching	O ₂
Treatment ²	O ₁	X ₂ . CTE Reading	O ₂
Control	O ₁	X ₃ . control	O ₂

Data Collection Plan

Variables. The independent variable in this study was the implementation of disciplinary literacy strategies. Dependent variables in this study were students' reading comprehension and motivation to read. The antecedent variables were gender, grade level, ethnicity, parents' level of education, reading disabilities, and socioeconomic status (SES) as measured by participation in subsidized school lunch programs. In order to control for preexisting student conditions, a standardized reading assessment score, grade point averages (GPAs), and pretest scores on motivation to read were treated as covariates.

Disciplinary literacy framework interventions. The interventions for this research included the MAX Teaching (MAX) approach (Forget, 2004) and the CTE Reading framework. The CTE Reading framework was developed from a literature review of content area reading strategies in the before-, during-, and after-reading microperiods (Snow, 2002). Both interventions were compared to a control condition, which was a "business as usual" condition.

Instrumentation. A student's reading comprehension was assessed using the GMRT for Grades 7-9 and content reading inventories. The GMRT is a norm-referenced test that measures comprehension and vocabulary. This study used forms S and T. The assessment consists of 48 multiple-choice items assessing students' comprehension on several short passages. Reliability ranged from .88 to .92. Although the GMRT assessed various types of reading genre, we were most interested in the expository texts.

Motivation to read was assessed with the MRQ. The MRQ was developed by John Guthrie, an expert in reading motivation, and adapted through previous studies (Park & Osborne, 2007) to reflect language more appropriate for high school students. The MRQ consists of 29 items to which students respond on a seven-point Likert-type scale, ranging from (1) *very different from me*, to (7) *a lot like me*. The MRQ score was treated as interval data and developed by summing the individual item responses for the 29 items. Validity was established with a panel of experts at the National Reading Research Center. Reliability of the instrument ranged from .56 to .74.

Data collection procedures. Prior to initiating the study, students' most recent grade point average, gender, grade level, ethnicity, parents' level of education, reading disabilities, and socioeconomic status (SES) as measured by participation in a free or reduced-price lunch

program was collected. The treatment period began on March 1 and concluded on May 15. Approximately one week prior to initiating experimentation, students completed the MRQ and the GMRT. The reading motivation assessment determined students' predisposition to read and reading habits. We maintained student confidentiality by asking teachers to provide an identifying code number to correspond to each student for all student data. All records provided to the research team were coded with numbers and no student names were provided. Individual CTE teachers collected all data. At the beginning of the spring semester, we requested students' GPAs, gender, ethnicity, free and reduced-price lunch data, and documented reading disabilities.

Population

Students enrolled in secondary CTE courses possess an array of academic and reading abilities, ranging from students with learning disabilities to college-preparatory students. Because CTE courses are offered as electives, students may enroll in these courses in order to escape reading pressures from other academic courses. A significant percentage of CTE students may be considered "at-risk" for reading failure and/or may be those students for whom reading in other disciplines is relatively easy, but who may find reading in highly technical CTE fields a challenge. The population for the research was all secondary students enrolled in CTE courses. Student assent and parental consent were secured for all students involved in the study for data collection, focus group interviews, and audio-recording. The specific sample for the pilot testing phase included those students enrolled in the CTE courses taught by treatment group teachers in upstate New York.

Teacher selection. In order to enhance participation in the study, teachers were an integral part of the research process. Teachers were paid a maximum stipend of \$750 at the completion of the pilot testing phase. Further, each teacher's local school principal and superintendent were notified of the teacher's desire to participate in the study. The administrator's permission was requested to allow the teacher to participate. Thus, once permission from the administrator was secured, we had created a partnership with the administration for participation in the study.

Professional development of teachers. In order for the treatment to be effectively implemented by all teachers in the treatment group, the principal investigators conducted intensive professional development workshops with the participating teachers. This professional development for treatment teachers included an introduction to and explanation of the reading strategies, strategy modeling by the research team for the teachers, teacher practice with the strategies as both learners and teachers, incorporation of the strategies into lessons, and microteaching with feedback from peer teachers. Teachers worked collaboratively to identify (a) how they use texts in their courses and (b) authentic opportunities for strategy implementation. Further, the professional development included guidelines and practice with journaling and treatment fidelity. For effective implementation, teachers in the treatment group had disciplinary literacy strategies explained to and modeled for them. Additionally, teachers both used the strategies themselves and taught their fellow teachers to use them.

Students were similarly trained in the use of reading strategies within their individual CTE classrooms. During a particular lesson, teachers explained the strategy being used, modeled the strategy's use, and then allowed students to practice using the strategy with authentic texts to aid

learning in their CTE courses. Teachers scaffolded instruction so that students received additional individual assistance early in the lesson, and then the teacher relinquished control of learning to students as they demonstrated greater proficiency with the learning and use of the strategies. Each new strategy was modeled for students when they encountered the strategy in their courses.

Sampling design. Our sample size was adequate to discover differences and effects while avoiding significant results because of inflated sample sizes (Gall et al., 2003; Kelley & Maxwell, 2003). Four factors determined sample size: significance level, statistical power, analysis procedure, and effect size (Olejnik, 1984). Sample size planning included multiple regression and emphasized accuracy in parameter estimation (AIPE) in order to ensure that likely widths of confidence intervals were sufficiently narrow (Kelley & Maxwell, 2003). The formula for sample size was:

$$N = [z_{(1-\alpha/2)} / w]^2 [(1 - R^2) / (1 - R_{xxj}^2)] + p + 1, \text{ where}$$

N = sample size
 $z_{(1-\alpha/2)}$ = z-score for the alpha level desired
 w = desired half-width of the confidence interval
 R^2 = observed population multiple correlation coefficient of the model predicting the dependent variable
 R_{xxj} = observed multiple correlation coefficient predicting the j^{th} predictor
 p = number of variables (independent, covariate, etc.)

We determined that a minimum of 107 subjects was needed in each treatment group to ensure adequate significance level, statistical power, analysis procedure, and effect size (Olejnik, 1984). In order to ensure this minimum, we over-sampled to accommodate for teachers and students dropping out of the study. The z-score for the desired alpha level ($\alpha = 0.10$) was 1.64, whereas the width of the associated confidence interval was 0.20. The population observed multiple correlation coefficient of the model predicting the dependent variable was 0.80 based on reviews of research, and the observed multiple correlation coefficient predicting the j^{th} predictor was 0.30, again from reviews of research. The maximum number of variables for any individual analysis, including independent, covariate, and regressor variables, was 5. The following sample size calculation was used: $N = [1.64/0.10]^2 [(1 - 0.8^2)/(1 - 0.30^2)] + 5 + 1 = 107$.

Random selection of subjects was impossible due to existing student course schedules. Thus, a quasi-experimental design was used with intact groups of students and teachers. We randomly assigned teachers, and therefore their classes, to the treatment and control groups. After the random assignment of classes to treatment and control groups, CTE teachers implemented the reading strategy instruction treatment.

Treatment Fidelity

Procedures were taken to ensure conformity of teaching approaches and use of reading strategies. All teachers participated in professional development on the integration of disciplinary literacy strategies and data collection procedures to ensure proper treatment and data collection. All teachers received example lesson plans outlining how to implement the reading strategies. Lesson plans included all necessary materials for proper implementation of the strategies, including the content and teaching methods, visual aids, assessments, and student materials.

Because we were engaging teachers and students in a longitudinal study of the intervention, intervention fidelity was crucial to understanding the impact of the treatment on the outcome variables. In the pilot-testing phase, we developed and validated an observational tool to ensure the fidelity of the intervention. The observation rubric was developed so as to ensure that teachers in the treatment were using the prescribed intervention, thus ensuring treatment fidelity. The rubric was also used to ensure that teachers in the control group used only the minimal literacy instruction of assigning readings and questions and discussing the reading in class. Further, the rubric was designed so that future cooperating CTE teachers may also be observed and evaluated for treatment fidelity.

Videotaping all classes and reviewing the hours of tape was time-prohibitive, thus we used on-site observations of teachers and their own electronic journaling as a means of ensuring treatment fidelity. With multiple teachers at each school site, members of the research team observed more than one teacher on any given day. Our presence in the classroom was explained as part of the ongoing literacy study with teachers and their CTE classes. If teachers were not teaching the intervention, then corrective measures were taken. Corrective measures included, but were not limited to, classroom coaching or additional researcher observation and feedback on instructional strategies.

To ensure proper treatment delivery, all teachers—regardless of treatment or control assignment—journalled and tracked strategies used, duration of use, and day of use. Teachers submitted the journals on a weekly basis; these journals reflected their daily lessons for the prior week. During all phases of development, we implemented survey methodologies with students and teachers to gauge their reactions to and use of the treatment.

Data Analysis

Statistical analysis. These analyses were conducted with each set of data collected. Student demographic data were analyzed using means and *t* tests. We also conducted correlation analyses on the major variables of interest as a precursor to further, more detailed data analysis, including Analysis of Covariance (ANCOVA). For the MRQ questionnaire, we used a summated mean of individual items to garner conclusions about students' motivations for reading. The GMRT included a scoring rubric for vocabulary and comprehension.

Although the use of pretest/posttest designs is extremely common, there is disagreement concerning the most appropriate way to analyze such data (Warner, 2008). ANCOVA was implemented to evaluate the difference between pretest and posttest scores. Warner (2008)

defined ANCOVA as “an analysis in which group differences on means for one continuous Y outcome variable are assessed, statistically controlling for or removing any part of Y that is predictable from one or more covariates” (p. 996). The chief reason ANCOVA was implemented in the current analysis was to control for pretest scores. Controlling for the pretest afforded a clearer picture of the outcomes attained if the groups were equivalent on the pretest (covariate) variable.

Although Analysis of Variance (ANOVA) is commonly employed to evaluate gain scores (Huck & McLean, 1975), there is justification for using ANCOVA. ANCOVA is normally a more powerful and precise approach than ANOVA on gain scores in randomized designs. Additionally, because of less significant errors in ANCOVA, it is feasible that using ANOVA of gains might lead one to miss the significance level needed to reject the hypothesis that all groups gained the same amount (Maxwell & Delaney, 2004). Maxwell and Delaney also revealed that “The ANOVA full model has 1 more degree of freedom, which translates into a slightly lower critical value than for ANCOVA. Except for very small sample sizes, the advantage is inconsequential and far outweighed by the smaller error variance of the ANCOVA model” (p. 446).

Qualitative analysis of interviews and focus groups. Because this intervention would only be effective if future teachers implement it, and because CTE teachers would have the most consistent primary knowledge of student reactions to the intervention, we gathered qualitative evidence in the form of teacher interviews and student focus groups to assess the process of implementing the treatment. These analyses allowed us to determine how the intervention was successful and how it could be improved. These interviews and focus group sessions were also triangulated with actual classroom observations. The interviews, focus group sessions, and observations helped inform the quantitative portion of the research.

Interviews were conducted with teachers at the conclusion of the trial period. By asking Research Question 3 (see Technical Appendix A), we hoped to learn more about (1) preparing pre-service CTE teachers for literacy instruction and (2) more effectively reequipping current CTE teachers with instructional approaches to support literacy and create a classroom culture that scaffolds text as a learning tool. Teachers participating in the study were asked a series of questions in one-on-one interviews regarding their experiences in the study. The questions were designed to encourage reflection without interviewer interruption, which allowed teachers to discuss anything they found striking about their experiences using reading strategies. Teachers were self-selected and had a range of experience with literacy strategies, from recent professional development to no knowledge or prior implementation of strategies.

Focus groups were conducted with students at the conclusion of the pilot period to ascertain students’ perceptions of (1) reading in CTE, and (2) reading strategy use in CTE. Participants in these focus groups included 129 students whose teachers used disciplinary literacy strategies in their Spring 2009 CTE instruction. Students volunteered to participate in the 23 focus group interviews (8.29 hours of audio recordings) in June 2009. All students and their parents signed letters of informed consent.

Audio recordings from teacher interviews and student focus group were analyzed by transcribing the audiotapes of the conversations and using content analysis to determine themes and general conceptions about reading strategy instruction and use in CTE courses. Transcription was completed by an online dictation service, Medikin. All transcripts were reviewed by the research team and compared to actual audio recordings to ensure their accuracy.

Once the interviews were transcribed, the research team shared transcripts via email in order to conduct inductive analysis as outlined by Hatch (2002). The inductive analysis followed other models of inductive analysis (e.g., Glaser & Strauss, 1967; Miles & Huberman, 1994) and included a search for “patterns of meaning in data so that general statements about phenomena under investigation can be made” (Hatch, 2002, p. 161). We used inductive analysis to implement the following steps:

1. read data and identify frames of analysis,
2. create domains based on semantic relationships discovered within frames of analysis,
3. identify salient domains and assign them a code,
4. refine salient domains and keep record of emerging relationships,
5. decide if domains are supported by data,
6. complete analysis within domains,
7. search for themes across domains,
8. outline relationships within and among domains, and
9. select data excerpts to support the relationships. (Hatch, 2002)

We used an open coding system, checked with interrater reliability. This open coding identified general comments and concepts, which were then further analyzed through axial coding and grouping the evidence into topical categories that were more specific, descriptive, and useful for subsequent intervention development (e.g., evidence of effective implementation of the intervention). Emergent themes were checked among the team for validation and decisions on implementation in consecutive phases of the study. Again, these interviews, combined with student focus group sessions, classroom observations, and teacher journals of their daily instruction, served to triangulate formative evaluations of the intervention with what were, in essence, summative evaluations in the form of quantitative data and analyses of student performance of reading comprehension and motivation to read.

The audit trail for this research consisted of the audio recordings, interview transcripts, interview guides, list of interviewees, themes generated from the transcripts, and working conclusions about teachers’ perceptions of disciplinary literacy and cognitive strategy instruction in CTE. After the interviews were transcribed, we read the transcripts to identify themes running throughout the interviews (Creswell, 1998). Pertinent themes were assigned a code, and the data were reread to identify specific examples to support the themes. The research team wrote summaries of the interviewees’ constructed realities from the final themes.

Technical Appendix C: Evidence and Findings

Demographic Analyses of Participants

Over 1,300 students and 51 teachers participated in the pilot test of this study in the Spring 2009 semester. Nearly all students (89.9%) were high school juniors or seniors at the time of the study (see Table 1). Nearly 60% were female, and the vast majority were White (84.2%). Over 96% of the students spoke English as their native language. As a proxy for SES, we measured students' enrollment in free or reduced-price lunch programs; more than 40% of students were enrolled in some form of subsidized lunch. Half of the students' mothers had an education level that included more than a high school education, and 38.5% of the students' fathers had an education level that was more than a high school education.

Table 1

Descriptive Analysis of Students in Pilot Test of Authentic Literacy in CTE.

Demographic Characteristic	%	Demographic Characteristic	%
<u>Grade Level (n = 1,229)</u>		<u>Gender (n = 1,228)</u>	
9	3.7	Female	58.2
10	2.8	Male	41.6
11	46.1	Other	.2
12	43.8		
Other	3.7	<u>Native Language (n = 1,232)</u>	
		English	96.3
		Spanish	2.0
<u>Ethnicity (n = 1,231)</u>		Other	1.6
American Indian	1.1	<u>Free/Reduced Lunch Program (n = 1,214)</u>	
Black/African-American	3.5	Full-priced	59.4
Hispanic/Latino	5.7	Reduced-price	12.7
Asian	.3	Free lunch	25.1
Hawaiian/Pacific Islander	.3	Other	2.8
White	84.2		
Other	4.9	<u>Mother's Education Level (n = 1,182)</u>	
		<u>Father's Education Level (n = 1,143)</u>	
Less than high school	6.9	Less than high school	13.4
High school	42.1	High school	48.1
Some college	23.5	Some college	18.7
Bachelor's degree	20.3	Bachelor's degree	13.5
Master's degree	6.0	Master's degree	4.4
More than Master's	1.1	More than Master's	1.9

Correlation Analysis

We conducted correlation analysis of the major variables of interest as the second step of the overall data analysis (see Table 2) to determine the degree of relationships between these variables (Gall et al., 2003). We used the conventions of relationships provided by Davis (1971): *negligible* ($\alpha = .01$ to $.09$), *low* ($\alpha = .10$ to $.29$), *moderate* ($\alpha = .30$ to $.49$), *substantial* ($\alpha = .50$ to $.69$), and *very high* ($\alpha = .70$ to $.99$). The control was coded with a “0,” CTE Reading framework group was coded with a “1,” and MAX Teaching framework was coded with a “2.” Statistically significant correlations were observed between the treatment group and (1) the pretest GMRT vocabulary measure, (2) the pretest GMRT comprehension measure, (3) the posttest GMRT vocabulary measure, and (4) the change in GMRT comprehension measure. Of these, all would be considered *negligible* according to Davis’ conventions, except for the change in GMRT comprehension measure, which would be *low*.

Table 2

Correlations Among Major Variables of Interest

		<u>Pretest GMRT</u>			<u>Posttest GMRT</u>			<u>Gain GMRT</u>			Pretest	Posttest	Gain	
		Group	Total	Vocab	Comp	Total	Vocab	Comp	Total	Vocab	Comp	MRQ	MRQ	MRQ
Group		---	.080*	.070*	.075*	.113*	.084*	.121*	.065*	.039	.063*	.038	.031	-.009
Pretest GMRT	total	.080*	---	.901*	.938*	.765*	.769*	.661*	-.172*	-.040	-.209*	.288*	.265*	-.011
	vocabulary	.070*	.901*	---	.696*	.695*	.750*	.559*	-.147*	-.197*	-.067*	.239*	.213*	-.008
	comprehension	.075*	.938*	.696*	---	.713*	.674*	.649*	-.168*	.093*	-.294*	.285*	.268*	-.012
Posttest GMRT	total	.113*	.765*	.695*	.713*	---	.906*	.940*	.502*	.436*	.392*	.328*	.305*	.005
	vocabulary	.084*	.769*	.750*	.674*	.906*	---	.708*	.357*	.501*	.148*	.281*	.259*	.007
	comprehension	.121*	.661*	.559*	.649*	.940*	.708*	---	.553*	.326*	.536*	.321*	.301*	.003
Gain GMRT	total	.065*	-.172*	-.147*	-.168*	.502*	.357*	.553*	---	.721*	.881*	.107*	.121*	.019
	vocabulary	.039	-.040	-.197*	.093*	.436*	.501*	.326*	.721*	---	.307*	.100*	.120*	.018
	comprehension	.063*	-.209*	-.067*	-.294*	.392*	.148*	.536*	.881*	.307*	---	.078*	.084*	.014
Pretest	MRQ	.038	.288*	.239*	.285*	.328*	.281*	.321*	.107*	.100*	.078*	---	.742*	-.292*
Posttest	MRQ	.031	.265*	.213*	.268*	.305*	.259*	.301*	.121*	.120*	.084*	.742*	---	.425*
Gain	MRQ	-.009	-.011	-.008	-.012	.005	.007	.003	.019	.018	.014	-.292*	.425*	---

* Significant at $\alpha = .10$. Incidentally, all correlations were significant at $\alpha = .05$.

Effect of Treatment Group on GMRT and MRQ

To ensure that the random assignment of teachers, and thus their classes, to either of the two treatment groups or the control group generated equality of group means, we conducted ANOVA on the pretest scores for GMRT vocabulary, GMRT comprehension, combined overall GMRT score, and MRQ score (see Table 3). Thus, analyses of the impact of the treatments included ANCOVA of the gains in group means of GMRT total score, GMRT vocabulary, GMRT comprehension, and MRQ motivation measure among the three groups: control, CTE Reading framework, and MAX Teaching framework (see Table 4).

Table 3

Descriptive Statistics of Pretest and Posttest Scores for GRMT Total, GMRT Vocabulary, GMRT Comprehension, and MRQ

Group	Pretest			Posttest		
	<i>n</i>	<i>M</i>	<i>SE</i>	<i>n</i>	<i>M</i>	<i>SE</i>
	<u>GMRT vocabulary</u>					
Control	301	31.61	.52	262	30.46	.62
CTE Reading	469	31.36	.40	399	31.20	.48
MAX	460	33.03	.40	395	32.53	.49
	<u>GMRT comprehension</u>					
Control	301	31.38	.66	262	27.66	.82
CTE Reading	468	32.54	.48	399	29.80	.57
MAX	458	33.49	.50	395	31.47	.60
	<u>GMRT Total</u>					
Control	301	62.99	1.09	262	58.12	1.33
CTE Reading	468	63.81	.80	399	61.00	.98
MAX	458	66.53	.82	395	64.00	1.00
	<u>MRQ</u>					
Control	309	105.67	1.68	262	108.60	1.85
CTE Reading	462	110.61	1.46	408	109.33	1.68
MAX	454	109.19	1.52	394	111.17	1.68

Table 4

Descriptive Statistics of Gain Scores for GRMT Total, GMRT Vocabulary, GMRT Comprehension, and MRQ

	<i>n</i>	<i>M</i>	<i>SE</i>	90% Confidence Interval for Mean
<u>Gain GMRT Total</u>				
Control	253	-5.49	.82	(-6.83, -4.14)
CTE Reading	381	-3.28	.67	(-4.38, -2.19)
MAX	390	-2.74	.66	(-3.83, -1.66)
<u>Gain GMRT Vocabulary</u>				
Control	253	-1.31	.41	(-1.97, -.64)
CTE Reading	381	-.52	.33	(-1.06, .03)
MAX	390	-.41	.33	(-.95, .13)
<u>Gain GMRT Comprehension</u>				
Control	253	-4.32	.58	(-5.27, -3.37)
CTE Reading	381	-2.82	.47	(-3.59, -2.04)
MAX	390	-2.19	.47	(-2.95, -1.42)
<u>Gain MRQ</u>				
Control	248	1.75	1.39	(-.55, 4.05)
CTE Reading	376	-1.28	1.13	(-3.15, .58)
MAX	386	1.57	1.12	(-.27, 3.41)

Overall GMRT scores. ANOVA of the pretest overall GMRT scores resulted in statistically significant differences among the groups (see Table 5). Post hoc analyses resulted in statistically different group mean scores between the control group and MAX framework group, as well as between the CTE Reading group and MAX framework group (see Table 6). Because group differences existed on these pretest scores in spite of random assignment, ANCOVA, controlling for pretest overall GMRT scores, was conducted on the gain scores of treatment groups.

Table 5

ANOVA of Pretest Scores for Total GMRT Score Across the Control, CTE Reading, and MAX Teaching Groups to Ensure Equality of Groups After Random Assignment

Source	Type III Sum of Squares	df	MS	F	α	Partial η^2
Corrected Model	2781.394	2	1390.697	4.351	.013	.007
Intercept	4890190.124	1	4890190.124	15299.367	.000	.926
Group	2781.394	2	1390.697	4.351	.013	.007
Error	391231.383	1224	319.633			
Total	5517814.000	1227				
Corrected Total	394012.778	1226				

$R^2 = .007$ (adjusted $R^2 = .005$)

Table 6

Post Hoc Analysis of ANOVA of Pretest Scores for Total GMRT Score to Determine Differences in Mean Scores

(I) Group	(J) Group	Mean Difference (I-J)	SE	α^a	90% Confidence Interval for Difference ^a
Control	CTE Reading	-.82	1.32	.900	(-3.62, 1.98)
	MAX	-3.54*	1.33	.023	(-6.35, -.73)
CTE Reading	Control	.82	1.32	.900	(-1.98, 3.62)
	MAX	-2.72*	1.18	.061	(-5.21, -.24)
MAX	Control	3.54*	1.33	.023	(.73, 6.35)
	CTE Reading	-2.72*	1.18	.061	(.24, 5.21)

* The mean difference was significant at the .10 level.

^a Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

ANCOVA of the mean gain in total GMRT scores, controlling for pretest GMRT total score, showed that the difference in at least one of these scores was statistically significant, $F(3, 2) = 3.62$, $\alpha = .027$, among the three groups (see Table 7). Post hoc tests using an Least Significant Difference (LSD) adjustment, equivalent to no adjustment, showed that students in the CTE Reading framework scored statistically higher than students in the control condition ($M = 2.20$, $\alpha = .037$; see Table 8). Further, students in the MAX Teaching framework scored statistically higher than students in the control condition ($M = 2.74$, $\alpha = .009$). The analysis showed no statistically significant difference in the means of the MAX Teaching framework compared to the CTE Reading group. Thus, controlling for pretest GMRT total score, we rejected the first two null hypotheses, H^0_{1a} (no statistically significant difference in the gain scores for total GMRT scores of students in the MAX Teaching group compared to the control group) and H^0_{1b} (no significant difference in the gain scores for total GMRT scores of students in the CTE Reading group compared to the control group; see Table 21). We failed to reject the third null hypothesis, H^0_{1c} (no statistically significant difference in the gain scores for total GMRT scores of students in the MAX Teaching group compared to the CTE Reading group).

Table 7

ANCOVA: Gain in Total GMRT Score, Controlling for Total GMRT Pretest Score

Source	Type III Sum of Squares	<i>df</i>	<i>MS</i>	<i>F</i>	α	Partial η^2
Corrected Model	6510.23	3	2170.08	12.88	.000	.036
Intercept	1583.31	1	1583.31	9.40	.002	.009
Pretest GMRT Total	5534.96	1	5534.96	32.84	.000	.031
Group	1221.38	2	610.69	3.62	.027	.007
Error	171899.00	1020	168.53			
Total	191829.00	1024				
Corrected Total	178409.23	1023				

$R^2 = .036$ (adjusted $R^2 = .034$)

Table 8

Post Hoc Analysis of ANCOVA: Gain in Total GMRT Score, Controlling for Total GMRT Pretest Score

(I) Group	(J) Group	Mean Difference (I-J)	SE	α^a	90% Confidence Interval for Difference ^a
Control	CTE Reading	-2.20*	1.05	.037	(-3.94, -.47)
	MAX	-2.74*	1.05	.009	(-4.47, -1.02)
CTE Reading	Control	2.20*	1.05	.037	(.47, 3.94)
	MAX	-.54	.94	.565	(-2.08, 1.00)
MAX	Control	2.74*	1.05	.009	(1.02, 4.47)
	CTE Reading	.54	.94	.565	(-1.00, 2.08)

* The mean difference was significant at the .10 level.

^a Adjustment for multiple comparisons: Least Significant Difference.

GMRT Vocabulary Scores. ANOVA of pretest GMRT vocabulary scores resulted in statistically significant differences among the groups (see Table 9). Post hoc analyses resulted in statistically different group mean scores between the control group and MAX framework group, and between the CTE Reading group and MAX framework group (see Table 10). Because group differences existed on these pretest scores in spite of random assignment, ANCOVA, controlling for pretest GMRT vocabulary scores, was conducted on the gain scores of treatment groups.

Table 9

ANOVA of Pretest Scores for GMRT Vocabulary across the Control, CTE Reading, and MAX Teaching Groups to Ensure Equality of Groups after Random Assignment

Source	Type III Sum of Squares	df	MS	F	α	Partial η^2
Corrected Model	720.697	2	360.349	4.760	.009	.008
Intercept	1208089.523	1	1208089.523	15958.420	.000	.929
Group	720.697	2	360.349	4.760	.009	.008
Error	92886.753	1227	75.702			
Total	1356714.000	1230				
Corrected Total	93607.450	1229				

$R^2 = .008$ (adjusted $R^2 = .006$)

Table 10

Post Hoc Analysis of ANOVA of Pretest Scores for GMRT Vocabulary to Determine Differences in Mean Scores

(I) Group	(J) Group	Mean Difference (I-J)	SE	α^a	90% Confidence Interval for Difference ^a
Control	CTE Reading	-.25	.64	.974	(-1.11, 1.61)
	MAX	-1.42*	.65	.081	(-2.79, -.06)
CTE Reading	Control	-.25	.64	.974	(-1.61, 1.11)
	MAX	-1.67*	.57	.011	(-2.87, -.46)
MAX	Control	1.42*	.65	.081	(.06, 2.79)
	CTE Reading	1.67*	.57	.011	(.46, 2.87)

* The mean difference was significant at the .10 level.

^a Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

ANCOVA of the gain in GMRT vocabulary scores, controlling for pretest GMRT vocabulary scores, showed that the group was not a statistically significant, $F(3, 2) = 1.65$, $\alpha = .193$ factor in the overall model (see Table 6). However, in post hoc analyses of mean gain scores for GMRT vocabulary, students in the MAX Teaching group had statistically higher scores ($M = .89$, $\alpha = .087$) than the control group scores (see Table 12). ANCOVA showed no statistically significant difference in the means of the MAX Teaching framework compared to the CTE Reading group. We rejected the null hypothesis H_{2a}^0 (no statistically significant difference in the gain scores for GMRT vocabulary of students in the MAX Teaching group compared to the control group), and failed to reject H_{2b}^0 (no statistically significant difference in the gain scores for GMRT vocabulary of students in the CTE Reading group compared to the control group; see Table 21). Also, we failed to reject the sixth null hypothesis, H_{2c}^0 (no statistically significant difference in the gain scores for GMRT vocabulary gain scores of students in the MAX Teaching group compared to the CTE Reading group).

Table 11

ANCOVA: Gain in GMRT Vocabulary, Controlling for GMRT Vocabulary Pretest Score

Source	Type III Sum of Squares	<i>df</i>	<i>MS</i>	<i>F</i>	α	Partial η^2
Corrected Model	1856.53	3	618.84	14.91	.000	.042
Intercept	1170.95	1	1170.95	28.20	.000	.027
Pretest GMRT Vocabulary	1741.32	1	1741.32	41.94	.000	.039
Group	136.69	2	68.34	1.65	.193	.003
Error	42347.22	1020	41.52			
Total	44666.00	1024				
Corrected Total	44203.75	1023				

$R^2 = .042$ (adjusted $R^2 = .039$)

Table 12

Post Hoc Analysis of ANCOVA: Change in GMRT Vocabulary, Controlling for GMRT Vocabulary Pretest Score

(I) Group	(J) Group	Mean Difference (I-J)	<i>SE</i>	α^a	90% Confidence Interval for Difference ^a
Control	CTE Reading	-.79	.52	.132	(-1.65, .07)
	MAX	-.89*	.52	.087	(-1.75, -.04)
CTE Reading	Control	.79	.52	.132	(-.07, 1.65)
	MAX	-.10	.47	.823	(-.87, .66)
MAX	Control	.89*	.52	.087	(.04, 1.75)
	CTE Reading	.10	.47	.823	(-.66, .87)

^a Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

* The mean difference was significant at the .10 level.

GMRT Comprehension Scores. ANOVA of the pretest GMRT comprehension scores resulted in statistically significant differences among the groups (see Table 13). Post hoc analyses resulted in statistically different group mean scores between the control group and MAX framework group (see Table 14). Because group differences existed on these pretest scores in spite of random assignment, ANCOVA, controlling for pretest GMRT comprehension scores, was conducted on the gain scores of treatment groups.

Table 13

ANOVA of Pretest Scores for GMRT Comprehension Across the Control, CTE Reading, and MAX Teaching Groups to Ensure Equality of Groups After Random Assignment

Source	Type III Sum of Squares	<i>df</i>	<i>MS</i>	<i>F</i>	α	Partial η^2
Corrected Model	814.269	2	407.134	3.497	.031	.006
Intercept	1241599.999	1	1241599.999	10665.176	.000	.897
Group	814.269	2	407.134	3.497	.031	.006
Error	142493.518	1224	116.416			
Total	1448149.000	1227				
Corrected Total	143307.786	1226				

$R^2 = .006$ (adjusted $R^2 = .004$)

Table 14

Post Hoc Analysis of ANOVA of Pretest Scores for GMRT Comprehension to Determine Differences in Mean Scores

(I) Group	(J) Group	Mean Difference (I-J)	<i>SE</i>	α^a	90% Confidence Interval for Difference ^a
Control	CTE Reading	-1.16	.80	.376	(-2.85, .53)
	MAX	-2.11*	.80	.025	(-3.81, -.42)
CTE Reading	Control	1.16	.80	.376	(-.53, 2.85)
	MAX	-.95	.71	.449	(-2.45, -.55)
MAX	Control	2.11*	.80	.025	(.42, 3.81)
	CTE Reading	.95	.71	.449	(.55, 2.45)

* The mean difference was significant at the .10 level.

^a Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

ANCOVA, controlling for pretest GMRT comprehension scores, showed that the group was a statistically significant factor, $F(3, 2) = 4.19$, $\alpha = .015$, in the overall model (see Table 15). Further post hoc analyses of mean gain scores for GMRT comprehension showed that students in the CTE Reading group had statistically higher scores ($M = 1.50$, $\alpha = .044$) than students in the control condition. Students in the MAX Teaching group had statistically higher scores ($M = 2.13$, $\alpha = .004$) than students in the control group (see Table 16). There was no statistically significant difference in GMRT comprehension gain scores between the CTE Reading and MAX Teaching groups. Thus, we rejected both null hypotheses H_{3a}^0 (no statistically significant difference in the gain scores for GMRT comprehension of students in the MAX Teaching group compared to the control group) and H_{3b}^0 (no statistically significant difference in the gain scores for GMRT comprehension of students in the CTE Reading group compared to the control group) (see Table

21). We failed to reject the ninth null hypothesis, H^0_{3c} (no statistically significant difference in the gain scores for GMRT comprehension gain scores of students in the MAX Teaching group compared to the CTE Reading group).

Table 15

ANCOVA: Gain GMRT Comprehension, Controlling for Pretest GMRT Comprehension

Source	Type III Sum of Squares	<i>df</i>	<i>MS</i>	<i>F</i>	α	Partial η^2
Corrected Model	8889.40	3	2963.13	35.28	.000	.094
Intercept	3265.34	1	3265.34	38.88	.000	.037
Pretest GMRT Comprehension	8453.52	1	8453.52	100.65	.000	.090
Group	703.25	2	351.63	4.19	.015	.008
Error	85672.85	1020	83.99			
Total	103463.00	1024				
Corrected Total	94562.26	1023				

$R^2 = .094$ (Adjusted $R^2 = .091$)

Table 16

Post Hoc Analysis of ANCOVA: Gain in GMRT Comprehension, Controlling for Pretest GMRT Comprehension

(I) Group	(J) Group	Mean Difference (I-J)	<i>SE</i>	α^a	90% Confidence Interval for Difference ^a
Control	CTE Reading	-1.50*	.74	.044	(-2.73, -.28)
	MAX	-2.13*	.74	.004	(-3.35, -.91)
CTE Reading	Control	1.50*	.74	.044	(.28, 2.73)
	MAX	-.63	.66	.343	(-1.72, .46)
MAX	Control	2.13*	.74	.004	(.91, 3.35)
	CTE Reading	.63	.66	.343	(-.46, 1.72)

* The mean difference was significant at the .10 level.

^a Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

MRQ Scores. ANOVA of the pretest MRQ scores resulted in statistically significant differences among the groups (see Table 17). Post hoc analyses resulted in statistically different group mean scores between the control group and MAX framework group (see Table 18). Because group differences existed on these pretest scores in spite of random assignment, ANCOVA, controlling for pretest MRQ scores, was conducted on the gain scores of treatment groups.

Table 17

ANOVA of Pretest Scores for MRQ Score Across the Control, CTE Reading, and MAX Teaching Groups to Ensure Equality of Groups After Random Assignment

Source	Type III Sum of Squares	df	MS	F	α	Partial η^2
Corrected Model	4604.515	2	2302.257	2.341	.097	.004
Intercept	1.393E7	1	1.393E7	14167.789	.000	.921
Group	4604.515	2	2302.257	2.341	.097	.004
Error	1201631.505	1222	983.332			
Total	1.572E7	1225				
Corrected Total	1206236.020	1224				

$R^2 = .004$ (adjusted $R^2 = .002$)

Table 18

Post Hoc Analysis of ANOVA of Pretest Scores for MRQ Score to Determine Differences in Mean Scores

(I) Group	(J) Group	Mean Difference (I-J)	SE	α^a	90% Confidence Interval for Difference ^a
Control	CTE Reading	-4.94*	2.31	.094	(-9.81, -.06)
	MAX	-3.52	2.31	.338	(-8.41, 1.38)
CTE Reading	Control	-4.94*	2.31	.094	(.06, 9.81)
	MAX	1.42	2.07	.87	(-2.97, 5.81)
MAX	Control	3.52	2.31	.338	(-1.38, 8.41)
	CTE Reading	1.42	2.07	.87	(-5.81, 2.97)

* The mean difference was significant at the .10 level.

^a Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

ANCOVA, controlling for pretest MRQ scores, showed that group was not a statistically significant factor, $F(3, 2) = 2.09$, $\alpha = .124$, in the overall model (see Table 19). Post hoc analyses showed that MAX Teaching framework students had a statistically higher score than the CTE Reading group ($M = 2.86$, $\alpha = .073$; see Table 20). Control condition students had statistically higher gain scores ($M = 3.03$, $\alpha = .093$) than students in the CTE Reading group. Post hoc analyses showed no statistically significant differences between MAX Teaching framework students and control group students. After ANCOVA, we failed to reject the null hypothesis H_{4a}^0 (no statistically significant difference in the gain scores for MRQ of students in the MAX Teaching group compared to the control group) and rejected H_{4b}^0 (no statistically significant difference in the gain scores for MRQ of students in the CTE Reading group compared to the control group), though recognizing that control group scores were higher than

CTE Reading group (see Table 21). We rejected the null hypothesis, H_{4c}^0 (there will be no statistically significant difference in gain scores for MRQ gain scores of students in MAX Teaching group compared to CTE Reading group).

Table 19

ANCOVA: Gain MRQ, Controlling for Pretest MRQ

Source	Type III Sum of Squares	<i>df</i>	<i>MS</i>	<i>F</i>	α	Partial η^2
Corrected Model	47344.75	3	15781.58	32.68	.000	.089
Intercept	43474.58	1	43474.58	90.02	.000	.082
Pretest MRQ Total	44143.00	1	44143.00	91.40	.000	.083
Group	2018.48	2	1009.24	2.09	.124	.004
Error	485862.97	1006	482.97			
Total	533516.00	1010				
Corrected Total	533207.72	1009				

$R^2 = .089$ (Adjusted $R^2 = .086$)

Table 20

Post Hoc Analysis of ANCOVA: Gain in MRQ, Controlling for Pretest MRQ

(I) Group	(J) Group	Mean Difference (I-J)	<i>SE</i>	α^a	90% Confidence Interval for Difference ^a
Control	CTE Reading	3.03*	1.80	.093	(.07, 6.00)
	MAX	.18	1.79	.921	(-2.77, 3.13)
CTE Reading	Control	-3.03*	1.80	.093	(-6.00, -.07)
	MAX	-2.86*	1.59	.073	(-5.48, -.23)
MAX	Control	-.18	1.79	.921	(-3.13, 2.77)
	CTE Reading	2.86*	1.59	.073	(.23, 5.48)

* The mean difference was significant at the .10 level.

^a Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Table 21

Summary of Null Hypothesis Decisions

Null Hypothesis	ANCOVA
1) H^0_{1a} : There will be no significant difference in the gain scores for total GMRT scores of students in the MAX Teaching group compared to the control group.	reject
2) H^0_{1b} : There will be no significant difference in the gain scores for total GMRT scores of students in the CTE Reading group compared to the control group.	reject
3) H^0_{1c} : There will be no significant difference in the gain scores for total GMRT scores of students in the MAX Teaching group compared to the CTE Reading group.	fail to reject
4) H^0_{2a} : There will be no significant difference in the gain scores for GMRT vocabulary of students in the MAX Teaching group compared to the control group.	reject
5) H^0_{2b} : There will be no significant difference in the gain scores for GMRT vocabulary of students in the CTE Reading group compared to the control group.	fail to reject
6) H^0_{2c} : There will be no significant difference in the gain scores for GMRT vocabulary of students in the MAX Teaching group compared to the CTE Reading group.	fail to reject
7) H^0_{3a} : There will be no significant difference in the gain scores for GMRT comprehension of students in the MAX Teaching group compared to the control group.	reject
8) H^0_{3b} : There will be no significant difference in the gain scores for GMRT comprehension of students in the CTE Reading group compared to the control group.	reject
9) H^0_{3c} : There will be no significant difference in the gain scores for GMRT comprehension of students in the MAX Teaching group compared to the CTE Reading group.	fail to reject
10) H^0_{4a} : There will be no significant difference in the gain scores for MRQ of students in the MAX Teaching group compared to the control group.	fail to reject
11) H^0_{4b} : There will be no significant difference in the gain scores for MRQ of students in the CTE Reading group compared to the control group.	reject
12) H^0_{4c} : There will be no significant difference in the gain scores for MRQ of students in the MAX Teaching group compared to the CTE Reading group.	reject

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