

A Retrospective Evaluation of the Instructional Effectiveness of

**CORD Algebra I Curriculum**

Phase I

August 2005-April 2006

Prepared by

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Submitted April 7, 2006

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## **Executive Summary**

This report is phase one of a two phase evaluation of the *CORD Algebra I* curriculum, a contextualized algebra curriculum that emphasizes “real world” connections, strategic problem solving, and differentiated learning to meet the needs of both college bound and non-college bound students. The first phase is a retrospective evaluation of the curriculum to determine the instructional effectiveness of the CORD curriculum utilizing student information from the 2004-2005 school year. This report provides results collected from the sample schools (n=3) to evaluate the success of the curriculum. The students in this study represent a variety in gender, ethnicity, SES, and learning disabilities. They also represent college bound and non-college bound students.

In this initial evaluation, the Baylor Evaluation Services Center (BESC) found that students who were taught with the CORD curriculum performed as well as, and sometimes better than, their peers within their school on state assessments. The data also suggest that when students’ scores are compared with other schools within their state, as well as nationally, they tended to score as well as or better than their peers.

## **Background Information**

CORD Communications, Inc. (CCI) is a for-profit organization located in Waco, TX that publishes, markets and distributes nationally math and science curricula for use in public school systems. These curricula were developed by CORD, a nonprofit R&D agency committed to leading change in education. In an effort to produce the most effective math and science curriculum available for public schools, CORD engaged the Baylor Evaluation Services Center (BESC) in August of 2005 to conduct a retrospective evaluation of their most recent edition of algebra curriculum using existing student data. The curriculum is titled CORD Algebra 1.

## Purpose of the Study

Algebra is a crucial domain in regard to the relationships students develop with mathematics (Artigue et al., 2001) and a central focus of math reform in America (Kaput, 1999; Kulm, 2000; Phillips & Lappan, 1998). As such, it is incredibly important for those responsible for instructing students in algebra to assure that best practices are utilized. But what constitutes best practice? And what tools are available to assure students receive the best algebra education?

A review of the literature over the last decade presents a diverse picture of mathematics education in America. Articles abound with concern over meeting math standards (Brenner et al., 1997; Kulm, 2000; Witzel, Smith, & Brownell, 2001) by looking at the content of instruction (Brenner et al., 1997; Dare, 2000; Graves, 1998; Laughbaum, 2002), the approach to instruction (Artigue, 2001; Dare, 2000; Witzel et al., 2003), and the role and reform of math/algebra curriculum (Dare, 2000; Kulm, 2000).

The literature is consistent in indicating that best practices for algebra education include a contextual basis for learning. This includes stressing the “why” of learning in an effort to increase motivation (Dalton, 1994), as well as providing hands-on experiences for students (Brenner et al., 1997; Witzel et al., 2001). Additionally, best practices include assisting students in making connections/relationships through a functional approach to teaching algebra (Laughbaum, 2002) by understanding and appreciating the “algebraic thinking already done by our students, their working class parents, and other members of the community (Chazan, 1994).

Real world, or applied emphasis, has typically been associated with the tech program movements associated with Dr. Dale Parnell’s groundbreaking work, *The Neglected Majority*, published in 1985. And while it has been suggested that this approach may suffer from image problems, may increase demands on teachers, time and resources required for collaboration, and

may raise questions of academic rigor (Dare, 2000), authors such as Dalton (1994), go so far as to suggest that applied algebra is “more appropriate for all students in the bottom three quarters or two thirds of the student body.”

Best practices are not limited to instructional design or the role of the teacher in instruction. Curriculum selection is equally important. Several reviews of algebra curriculum suggest that textbooks need to maintain a “technical work” aspect in order to be most effective (Artigue et al., 2001). That is, curriculum, as well as teacher’s instructional methods, needs to continually find ways to keep algebra grounded in real world applications. Chazan (1994) concurs that “current algebra curriculum is in desperate need of reform; a new curriculum must be created that helps members of the public and students understand the why of mathematics education.”

In response to the curricular need to ground algebra in the “real world”, the Center for Occupational Research and Development (CORD) developed *CORD Algebra I: Mathematics in Context* to address the cognitive gaps that may exist between mathematics understanding and the abstract concepts that pervade much of traditional algebraic instruction. This is accomplished by employing hands-on experiences and work place applications within the teaching context to clearly teach abstract principles and concepts.

## Research Questions

The intent of the evaluation will be to give preliminary findings to the following questions:

- Is the *CORD Algebra I: Mathematics in Context* curriculum instructionally effective with students?
- Does algebra instruction based on the teacher’s edition and student texts significantly increase students’ algebra skills as measured by standardized state and/or national measures?

# Design of the Study

## *Study Population*

Districts and schools across the United States that utilize *CORD Algebra I* curriculum were obtained through the curriculum sales records provided to the BESC by CORD. Every district or school contact person on the list provided to the BESC was contacted via mail or e-mail over a three-month period, given a preliminary sketch of the CORD study, and invited to participate in the initial evaluation. Those districts/schools that expressed an interest were given a more detailed description of the data needed from them and asked to submit their data at their earliest convenience. Several follow-up e-mails and phone calls were made to participating sites to check on status of data collection and/or to clarify additional data/information needed from the schools. A hard deadline was set for the second week of January, but had to be extended for various reasons.

Initially, the evaluators recruited five schools to participate in this initial evaluation. Two of the five schools were eliminated from the study because of insufficient data or failure to provide researchers with data in a timely manner due to circumstances beyond their control. As such, this preliminary study was conducted in three participating schools from three different states: technical school in the north east (school “A”) and two high schools from the Midwest (school “B” & “C”).

Seven hundred eighty four students were included in this initial study. Of these students, approximately 19% (n-147) qualified for free or reduced lunch, 42.7% were female, 57.3% were male, and 26% represented ethnicities other than Caucasian. All students were in the 10<sup>th</sup> grade except for eighty-four 9th graders and six 11th graders from school B. These demographics seem to provide a significant amount of diversity for this study.

The communities where these schools are located range from a population of 3500 to 23,000, and a median income of \$40K per year. All three communities are predominantly

White/Non-Hispanic (85.7% is the average). School A is located in the northeastern United States, in a community that is above its state average in income and below its state average for black and Hispanic students. Its top two primary industries are education, health, and social services (23%) and retail (15.7%). School B is located in a Midwestern community that is slightly above state average in income and well above its state average for black and Hispanic populations. Its top two primary industries are manufacturing (31.8%) and education, health, and social services (18.5%). Finally, School C is located in a community that has a lower income level than their state average, as well as has a larger black and Hispanic population than their state. The primary industries for this community are education, health, and social services (31.2%) and public administration (15.5%).

The following charts provide the demographic breakdown for each school:

## SCHOOL A

### Race/Ethnicity

	Frequency	Percent
White	321	89.4
Black	23	6.4
Hispanic	9	2.5
Asian	2	.6
Unknown	4	1.1
Total	359	100.0

### Gender

	Frequency	Percent
Male	239	66.6
Female	120	33.4
Total	359	100.0

### SES

	Frequency	Percent
Free/Reduced Lunch	68	18.9
No	291	81.1
Total	359	100.0

Race By Gender

		Gender		Total
		Male	Female	
Race	White	214	107	321
	Black	16	7	23
	Hispanic	6	3	9
	Asian	1	1	2
	Unknown	2	2	4
Total		239	120	359

**SCHOOL B**

**Race/Ethnicity**

	Frequency	Percent
Caucasian	87	73.7
Black	4	3.4
Hispanic	27	22.9
Total	118	100.0

**Gender**

	Frequency	Percent
Male	59	50.0
Female	59	50.0
Total	118	100.0

**SES**

	Frequency	Percent
Free/reduced lunch	17	14.4
No	101	85.6
Total	118	100.0

**Ethnicity by Gender**

		Gender		Total
		Male	Female	
Ethnicity	Caucasian	47	40	87
	Black	2	2	4
	Hispanic	10	17	27
Total		59	59	118

## SCHOOL C

### Ethnicity/Race

		Frequency	Percent
	Asian	14	4.6
	Indian	6	2.0
	Black	85	27.7
	Hispanic	25	8.1
	Caucasian	176	57.3
	Total	306	99.7
Missing	System	1	.3
Total		307	100.0

### Gender

		Frequency	Percent
	Male	169	55.0
	Female	137	44.6
	Total	306	99.7
Missing	System	1	.3
Total		307	100.0

### SES

		Frequency	Percent
	No	244	79.5
	Free/Reduced Lunch	62	20.2
	Total	306	99.7
Missing	System	1	.3
Total		307	100.0

### Ethnicity by Gender

		Gender		Total
		Male	Female	
Race	Asian	5	9	14
	Indian	3	3	6
	Black	48	37	85
	Hispanic	15	10	25
	Caucasian	98	78	176
Total		169	137	306

## *Research Design*

The initial study by the BESC is a retrospective evaluation of student performance on standardized tests by classes that utilized the CORD curriculum. Two of the schools (A & C) provided standardized test scores for students who were taught with CORD curriculum, as well as standardized scores for those students who were not taught with CORD curriculum. School A's scores are for two different years, while school C's scores are for students in the same year. School B only provided scores for students who were taught with CORD curriculum. Due to the varying nature in which data was provided, the methodology, rationale, and description of results will be reported by school in the following section.

## **Procedures & Results**

### ***SCHOOL A- TECH SCHOOL LOCATED IN NORTH EAST U.S.***

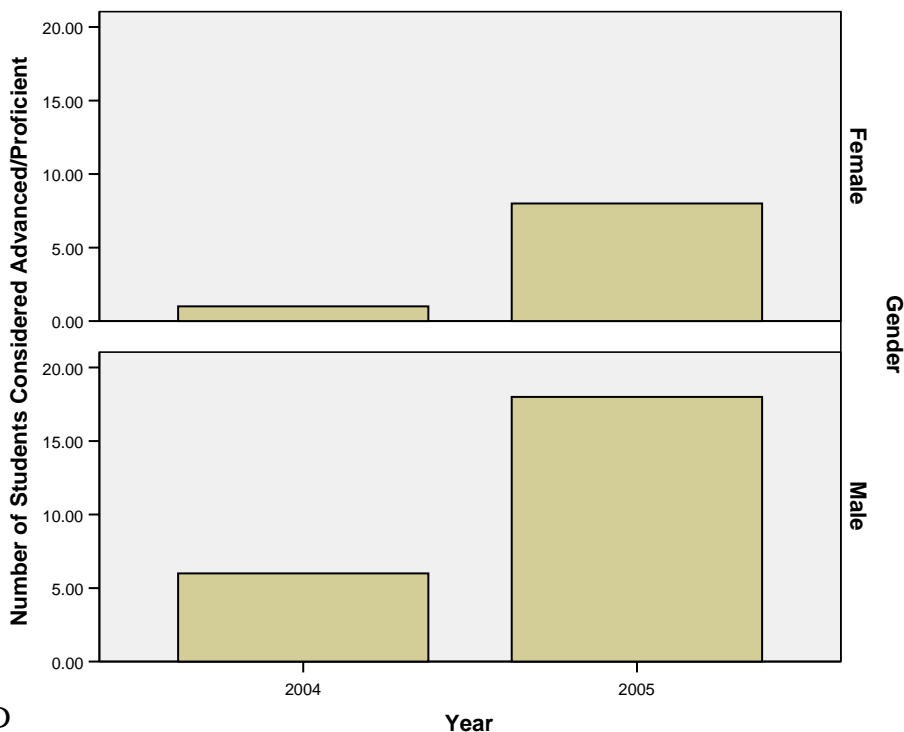
School A provided the BESC with scores on a standardized, norm referenced state exam for two different years. Students had to score high enough to be considered either *Advanced* or *Proficient* in order to pass the exam. The first year's scores (2004) were for students who were not taught using the CORD curriculum and the second year students (2005) were taught with CORD curriculum. The following chart illustrates how the students scored in each year:

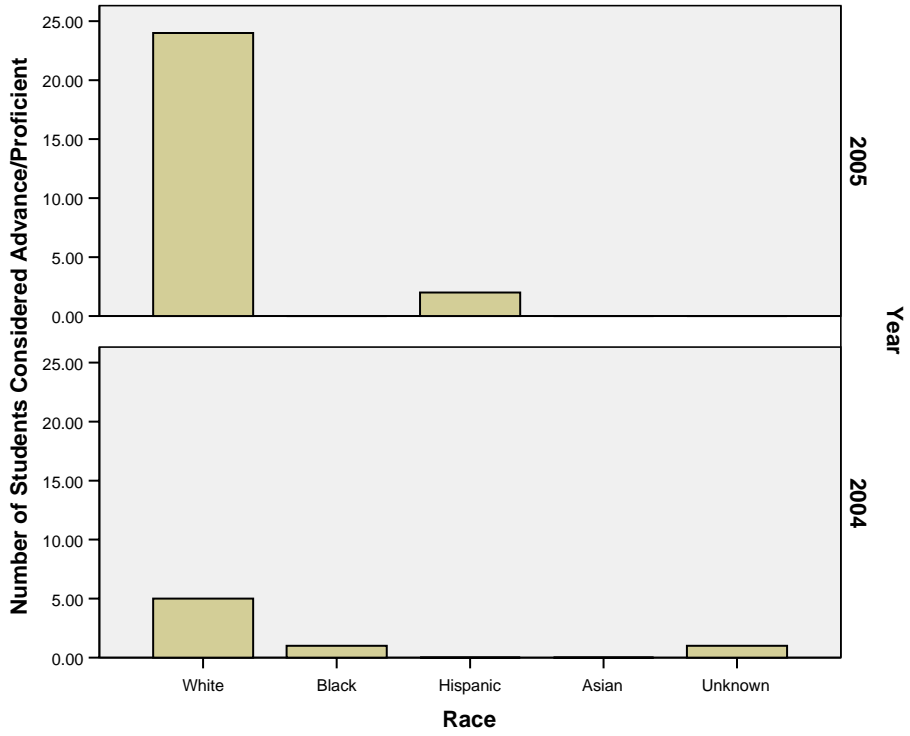
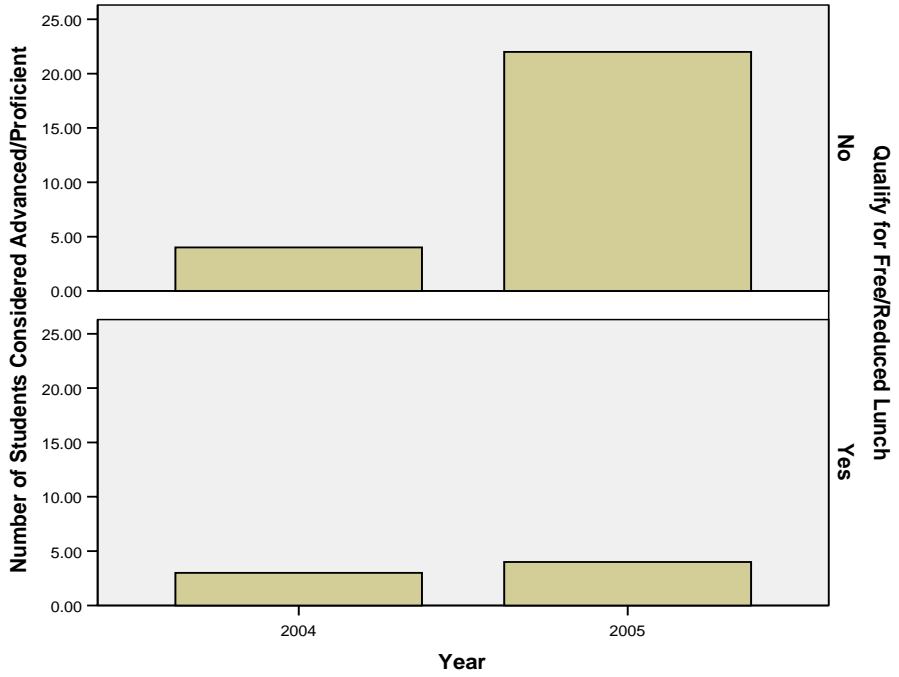
**Math Performance Scores for 2004 & 2005**

		Year		Total
		2004	2005	
Math Performance Score	Advanced	7	26	33
	Proficient	52	69	121
	Needs Improvement	95	67	162
	Failing	33	10	43
Total		187	172	359

The researchers initially ran an independent sample t-test for the main effect of year of instruction, but the sample failed the test for homogeneity of variance, so a nonparametric statistic, the Mann-Whitney, was utilized since it is not easily affected by heterogeneity of variance. This test accomplishes essentially what a t-test does when the distribution of the two samples deviates significantly from normal. The result of this test suggests that a significant difference between the two groups does exist, with the CORD group scoring higher than the non-CORD group ( $p < .001$ ).

Researchers were also interested in exploring who might have benefited the most from the CORD curriculum. An independent sample t-test suggested that there was no main effect for gender or SES, but a one way ANOVA suggests there was a main effect for race/ethnicity ( $F(4, 354) = 3.427, p < .009$ ). Despite these suggestions, there is no doubt that when these variables are compared against the particular year instead of one another, it is obvious that the CORD curriculum was a significant contributor to the success of the students. The one caveat is regarding race/ethnicity, in which black students seemed to have scored better with out the CORD curriculum. The following charts graphically demonstrate how each demographic compares based upon whether or not they were taught using CORD curriculum:





Additionally, when the students of this school that were taught with CORD curriculum and scored high enough to be considered *Advanced* and/or *Proficient* were compared to similar schools in the state, they fared quite well. School A students were in the top 20% of all the technical schools in their state, with 70.2% of their students scoring *Advanced/Proficient* compared to 61% statewide (33.9% difference). When compared to technical schools of similar size (+/- 50), students from School A were in the top 83%, which suggests a slight increase in standing.

### ***SCHOOL B- HIGH SCHOOL IN MIDWEST U.S.***

School B provided the BESC with national percentile rank scores from the ITED, the chosen standardized assessment by their state, for an algebra class that used the CORD curriculum. Statewide, the students' achievement levels were defined by the percentile-rank groupings 1-40 (*Less-than-Proficient*), 41-89 (*Proficient*), 90-99 (*Advanced*). The BESC maintained these labels for the evaluation.

The student scores for this school suggest that the CORD students performed quite well nationally, as well as compared to their school and state. Based upon state and district information, as well as data collected from participant School B, approximately 81% of the CORD students were rated as *Proficient/Advanced*, which is 1% lower than the entire school's proficiency rating (81.7%), but 2% higher than the state. The CORD students had 19.5% of their population rated *Less-than-Proficient*, which is only 1.3% more than the entire school. 78.8% of the CORD students were classified as *Proficient*, while the school had only 59.3%. This seems to suggest that a large portion of the school's overall *Proficiency* rating is based upon the performance of the CORD students.

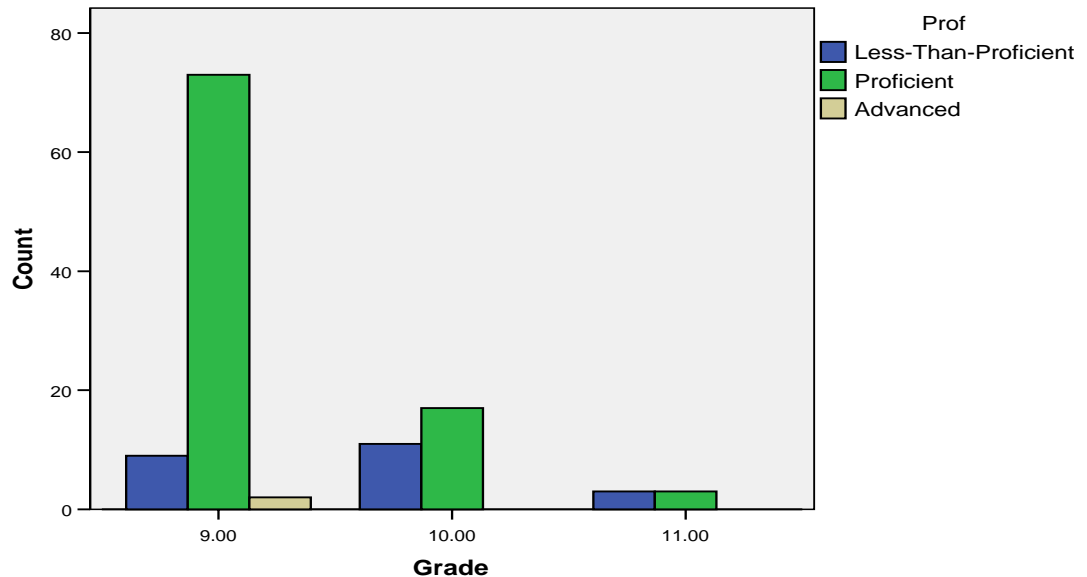
A correlation matrix was used to try to determine if there were any potential relationships between/among the scores and various demographics. This investigation yielded a significant correlation between SES and student scores ( $r = .352, p < .01$ ). As a result, the researcher ran a one

way ANOVA to test for a main effect of SES on student scores. Because these were reported as rank data, they were first converted to standardized Z scores. The ANOVA suggests there is a main effect for SES ( $F=(1, 116)=16.4, p<.001$ ). What this may suggest is that since there were no other significant correlations between the scores and demographics or between the varying demographics, that CORD curriculum appears to teach across gender and ethnic differences quite well.

The following tables and charts provide breakdowns of student performance by grade, gender, race/ethnicity, and SES:

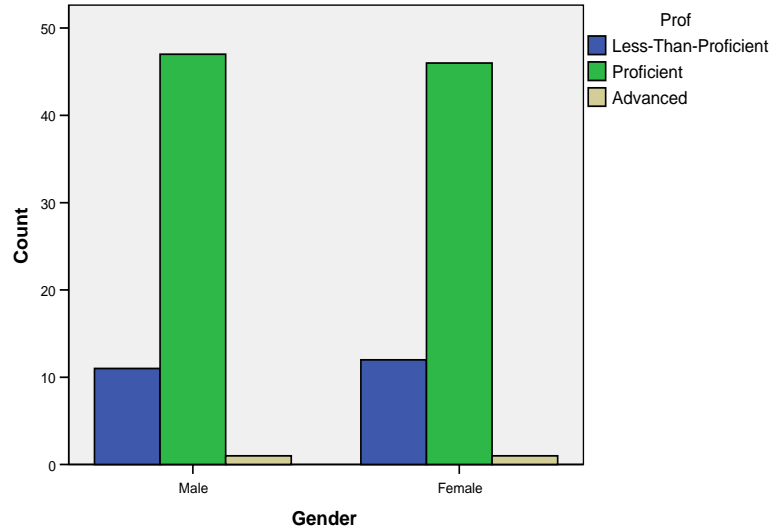
		Prof			Total
		Less-Than-Proficient	Proficient	Advanced	
Grade	9.00	9	73	2	84
	10.00	11	17	0	28
	11.00	3	3	0	6
Total		23	93	2	118

**Student Proficiency by Grade**



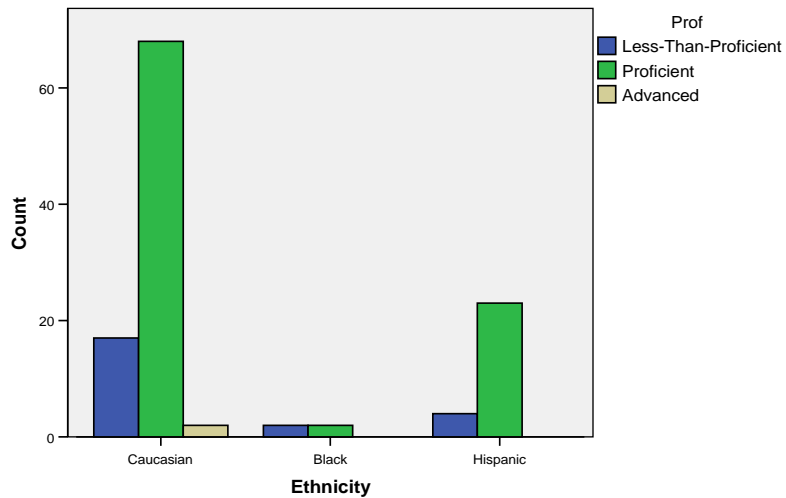
## Student Proficiency by Gender

		Prof			Total
		Less-Than-Proficient	Proficient	Advanced	
Gender	Male	11	47	1	59
	Female	12	46	1	59
Total		23	93	2	118



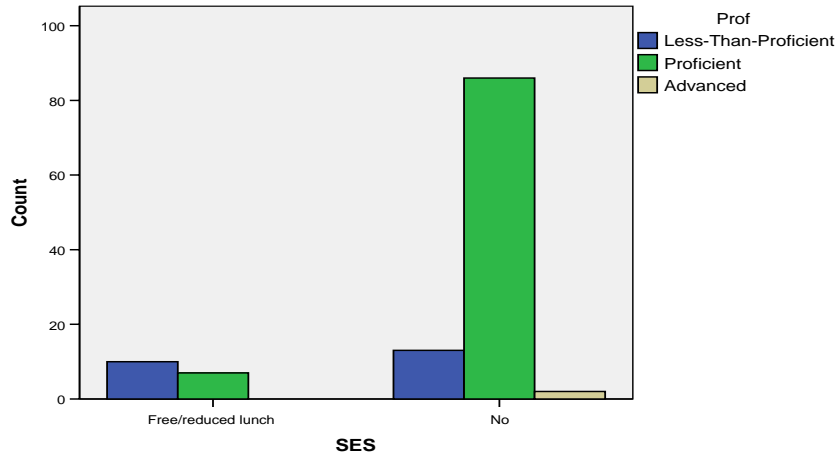
## Student Proficiency by Race/Ethnicity

		Prof			Total
		Less-Than-Proficient	Proficient	Advanced	
Ethnicity	Caucasian	17	68	2	87
	Black	2	2	0	4
	Hispanic	4	23	0	27
Total		23	93	2	118



## Student Proficiency by SES

		Prof			Total
		Less-Than-Proficient	Proficient	Advanced	
SES	Free/reduced lunch	10	7	0	17
	No	13	86	2	101
Total		23	93	2	118



### ***SCHOOL C: HIGH SCHOOL IN MIDWEST U.S.***

School C provided the researchers with math scores for all Algebra students within their school. These scores were from a standardized test used by their state for determining student and school performance on math. The scores of the students who were taught with the CORD curriculum were compared with the rest of the population. Additionally, because these scores were reported as percentile data, the researchers could compare how students taught with the CORD material compared to students nationwide.

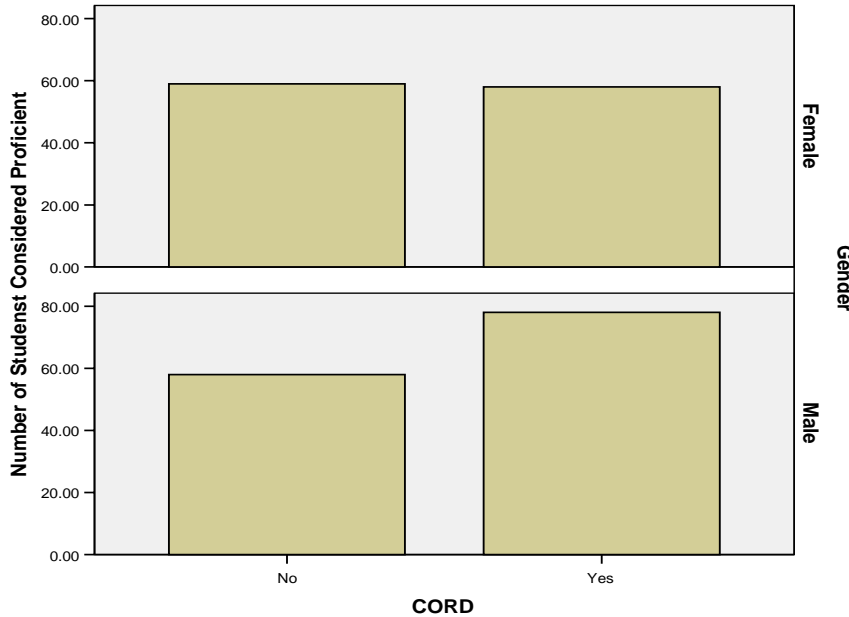
Because the reported data was ranked, as well as failed the Levene's Test for equality of variances due to the excessive number of high performing students (32% scoring more than 1sd above the mean) in the non-CORD population, The Mann-Whitney was used to compare the overall algebra student population with CORD students. It was determined that there was no statistically significant difference between CORD students and the rest of the population. While at first this does

not appear significant, the reality is that this suggests that the CORD students fared just as well as the rest of the population on the assessment.

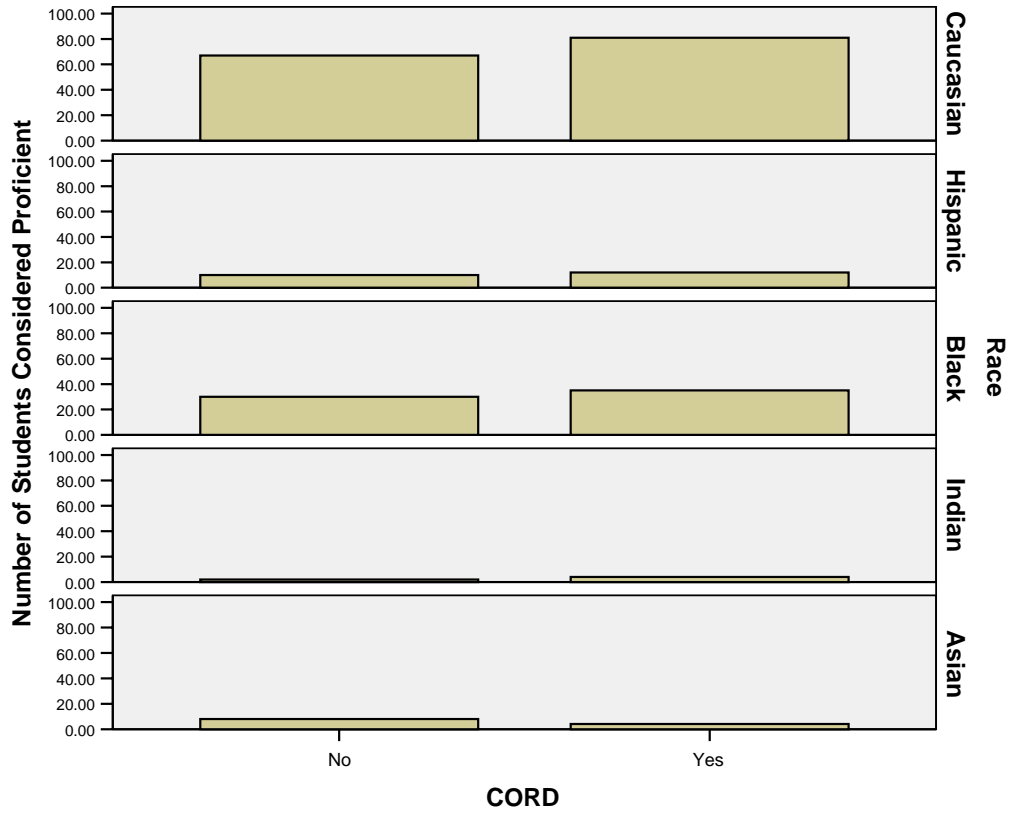
Additionally, by running a comparison of the two groups (CORD versus non-CORD), 96% of the students taught with the CORD curriculum scored above the national average, while only 71% of the non-CORD students scored above the national average.

The following charts provide graphic illustrations of the results by gender, race/ethnicity, and SES:

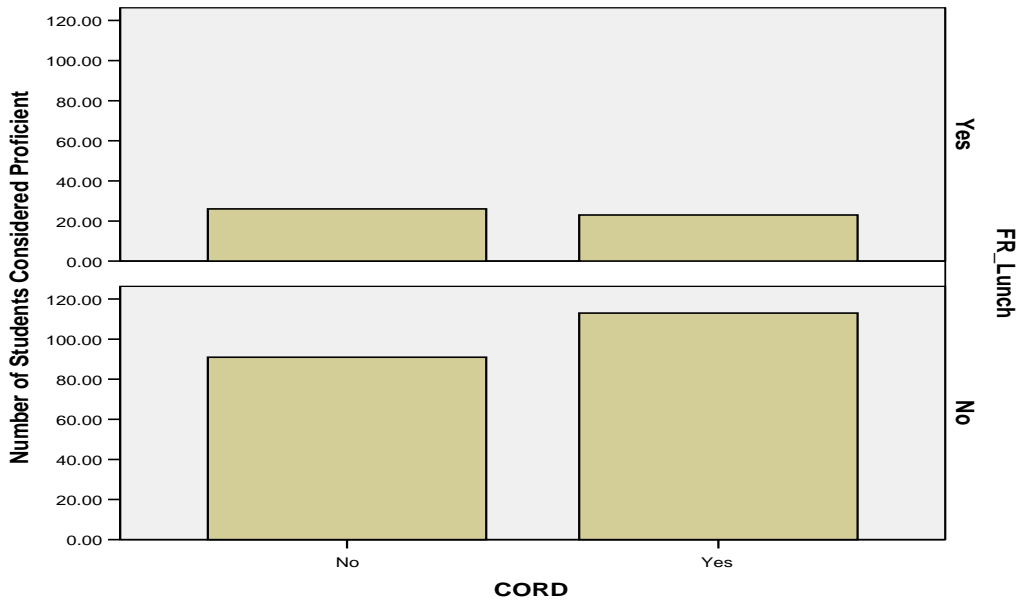
**Student Proficiency by Gender**



### Student Proficiency by Race/Ethnicity



### Student Proficiency by SES



## Conclusions

While evaluations of this nature have several inherent limitations, there are also several statistically significant conclusions that can be reached. Some of the more pertinent conclusions that this retrospective evaluation has reached appear to support the existing literature as it relates to (1) the appropriateness of curriculum, such as the *CORD Algebra I* curriculum, for a large portion of all high school students, (2) the apparent benefit of curriculum rooted in “real world” situations, and (3) the effectiveness of algebra textbooks that help students understand the why of mathematics education. In addition to affirming the literature, the research contained within this report also appears to adequately respond to the initial research questions that guided this evaluation: (1) Yes, the *CORD Algebra I: Mathematics in Context* does appear to be instructionally effective with students, and (2) Yes, Algebra instruction based upon the teacher’s edition and student texts significantly increases students’ algebra skills as measured by standardized state and/or national measures.

Based upon the scores provided by the three schools in this study and reports from their respective school districts, states, and national norms, it appears the students who were taught with CORD curriculum scored as well or better than their peers within their own school on standardized tests of math proficiency. In one of the sample groups, scores of students who were taught using the CORD curriculum were compared with the test scores of the entire student population at their school on a standardized test. It was discovered that while the non-CORD students scored higher on the test, there was a significantly larger ratio of CORD students than non-CORD students that passed the test, as well as scored better than 50% of the nation on the assessment. It would seem that if this result is replicable, there is evidence to suggest that the entire student population could

benefit from a curriculum such as the *CORD Algebra I*; if not the entire population, at least the lower two-thirds, as alluded to in the literature.

Likewise, CORD students at all three sites performed statistically as well or better than their peers across their state, as well as nationwide. Again, the performance of these students appear to suggest that the CORD approach to algebra education prepared these students well enough to demonstrate a proficiency in Algebra that set them apart from their peers who used other math curricula. As a result, it should also be noted that the successful performance of these students contributed to the overall success of their schools to perform well on state mandated tests. This obviously becomes an important observation for any school that may be investigating ways in which their school can perform better on standardized tests in accordance with NCLB.

Finally, the data from this evaluation seems to suggest that the CORD curriculum was equally effective across gender, race/ethnicity, learning ability, and SES. There was one school that seemed to indicate an inverse relationship between scores of CORD students and race; specifically with the black student population. While this researcher cannot make any speculation to account for this apparent anomaly, it should be balanced by the fact that the other two sites did not have the same inverse relationship occur. Instead, all the CORD students, regardless of gender, race/ethnicity, learning abilities, or SES seemed to perform better than their matched peers based upon the aforementioned demographic criteria. As such, this may suggest that something other than curriculum may have attributed to the discrepancy.

One possible reason for the apparent success of students being taught with the CORD curriculum is its being rooted in “real world” situations, which often times helps students understand the *why* of mathematics education. As such, students, regardless of gender, race/ethnicity, learning ability, or SES not only become more motivated to learn, but also

understand and can apply proficiently what they learn. The end result is a student body that is well equipped for a future, whether that future includes immediate entrance into the workforce, technical training, or in higher education.

### **Brief Summary of Significant Findings**

- There is significant evidence from our sample population to suggest that students who are taught with *CORD Algebra I* curriculum scored as well or better than their peers within their school on standardized assessments on math proficiency. On at least one occasion, this includes a comparison with a population of extremely high scoring students.
- When compared statewide, the groups taught with the CORD curriculum consistently had a greater percentage of students who were rated as *proficient* or better.
- When compared to national rankings, a large percentage of the students taught with the CORD curriculum scored better than average or in the upper percentiles.
- Both males and females seemed to benefit from the contextualized approach to algebra.
- All races/ethnicities seemed to benefit from the contextualized approach to algebra.
- CORD curriculum students seemed to fare well on standardized assessments across learning abilities.
- Students of various SES levels seemed to benefit from instruction based upon the CORD curriculum's contextualized approach.