About the Author

The author, Lee E. Blackwell, is a mathematics teacher at Lynwood High School in Lynwood, California. The school is a member of the Lynwood Unified School District (LUSD) which is part of the Los Angeles County of Education (LACOE). Mr. Blackwell has been teaching mathematics: Algebra 1, Algebra 2, and Geometry at the school since October 2005.

Mr. Blackwell holds a Bachelor of Science degree in Physics (1974) from Friends University in Wichita, Kansas. He completed two years of graduate study in physics at Wichita State University (1976) and entered the University of Nebraska, Lincoln, Nebraska to complete a doctorate in physics studying elementary particle physics. Due to the decreasing demand and poor job prospects in this field, Mr. Blackwell changed majors and received a Master's of Science in Industrial and Systems Engineering with a minor in physics in December 1978. Mr. Blackwell worked fifteen years in the aerospace industry as an operations analyst performing research and development studies on advanced military systems and mission planning. After leaving the industry, he worked as a business consultant specializing in new business development.

Mr. Blackwell began teaching in 2003 and obtained a fully accredited credential in secondary mathematics in 2007 from the State of California.

The issues raised in this document are the result of observations and concerns at the large numbers of students who were not capable of performing basic mathematical processes and consistently failed Algebra 1. He discovered that many students who were repeating Algebra 1 in high school (grades nine thru twelve) were not performing at acceptable levels on either district administered tests or state administered tests. I hope that the issues raised will spur further discussion and new ideas as to how we can help our students to achieve.

WHY DO STUDENTS PERFORM POORLY IN ALGEBRA?

MARCH 2011

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INTRODUCTION

As a high school mathematics teacher in the Lynwood Unified School District (LUSD) at Lynwood High School (LHS) I have had the privilege of seeing and teaching high school students in Algebra 1 and Algebra 2. Although the experience has been rewarding at times, I have to admit that the practice of teaching Algebra 1 to Grades 9 to 11 is difficult. During my six-year tenure at LHS, several complex questions have nagged at me in terms of trying to teach algebra to my students.

a. *First, why do significant numbers of students arriving in Grade 9 Algebra 1 lack basic skills in addition, subtraction, multiplication and division?*
b. *Second, why do students' scores decline significantly from Grade 7mathematics to Grade 8 Algebra 1?*
c. *Third, does it really benefit the student to continue repeating Algebra 1 after they have failed the course once, twice or three times?*

In the pages that follow, I will explore these three issues by showing data that confirms the existence of serious problems in the way students are prepared and achieve in algebra instruction. I will first examine the curriculum used to teach elementary mathematics with an emphasis on the California State Standards mandated for grades 2-6. This examination will show how the standards defined for specific grade levels lead to the ultimate goal of preparing Grade 8 students for Algebra 1 (Grade 8 is the traditional grade for teaching Algebra 1 in most California school districts). Next I will examine data derived from the California Department of Education which shows the performance of LUSD students on the California Standards Test (CST) and provides some historical perspective to what has become a serious problem in mathematics achievement in the district and the impacts it has on graduation rates and college readiness. The final part of the paper will address the issue of multiple re-enrollments in Algebra 1 and pose some alternative solutions to this circumstance which data shows does not improve student achievement.

WHAT IS THE FOUNDATION OF ALGEBRA?

According to Wikipedia and other sources: ***Algebra is the branch of mathematics concerning the study of the rules of operations and relations, and the constructions and concepts arising from them, including terms, polynomials, equations and algebraic structures.*** This definition is very important to teachers and parents and students. There appears to be a large amount of confusion about what algebra is. I have seen this confusion expressed by students as well as teachers. The study of algebra: the curriculum or pacing plan (many administrators advocate) does not allow for or propose the study of the basic skill of mathematics.

So, one must ask what is the foundation of algebra? How are students prepared for the study of algebra and thereby prepared for the study of higher mathematics which depends upon understanding the concepts of algebra? To examine the above questions I explored the California State Standards defined in the CST for mathematics for grades 2 thru 8. The CST

exam for mathematics consists of sixty-five questions encompassing FOUR clusters/strands of standards as shown by the pyramid in Figure 1.

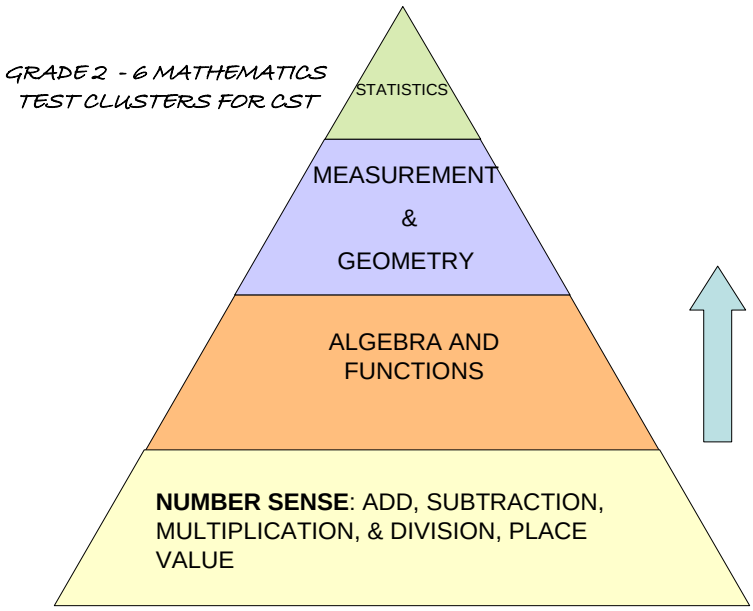


FIGURE 1: MATH STANDARDS GRADE 2-6

The four clusters provide the basis for all mathematics instruction in the State of California. It is reasonable to expect that Grade 2 teachers will teach subject matter in the same direction as the arrow indicates. Number Sense is the foundation of basic mathematics and provides the foundation for being able to calculate, correct, and verify mathematical processes defined by algebra. The reader will notice that "algebra and functions" is a Grade 2 strand. The purpose of this strand is to test that students understand how to apply rules that govern multiple processes. As an example of the how basic skills techniques transitions to algebra techniques examine the two problems from the Grade 2 Mathematics CST Released Questions. Figure 2 is a question from Number Sense Standard: 2NS2.2

22 [WHAT IS TWO HUNDRED FIFTEEN PLUS FIFTY-SEVEN?]

215
+57

A	**B**	**C**	**D**
158	262	271	272

FIGURE 2: EXAMPLE NUMBER SENSE PROBLEM

This example requires the student to perform a simple vertical addition of adding two numbers. Assuming students would become proficient in addition, etc the teacher would then

move to the next layer in the pyramid (Figure 1) and transition to an algebra problem such as that in Figure 3.

56 [WHICH NUMBER SENTENCE IS TRUE?]

A 15 +26 =26 + 15
B 15 +26 =26 + 41
C 15 +26 =51 + 62
D 15 +26 =15 + 19

Figure 3: EXAMPLE ALGEBRA PROBLEM

Figure 3 illustrates two issues for the Grade 2 student. First, the question asks that the student correctly add the numbers on the left and right side of the equations (also requiring that the student knows the definition of an equation) and that the student knows the commutative addition rules of algebra.

From the above examples, one can understand the link between basic math skills (number sense) and algebra (rules) and further understand that basic math skills knowledge must precede the teaching of algebra. Likewise, the two remaining strands "measurement and geometry" and "statistics" expands upon the rules defined by algebra such as calculating formulas (geometry) and performing averaging, etc (statistics).

Grades 3 to Grade 6 strands essentially expands upon the foundation laid in Grade 2. The Number Sense Strand serves as the foundation (defining, practicing, and mastering basic skills) with the Algebra Strand defining more and more rules and procedures for addressing more complex problem types. This growth is shown in Figure 4 and Figure 5. From Figures 4 and 5, one can see how the number sense strand gains in complexity over the five years of instruction. Students build upon

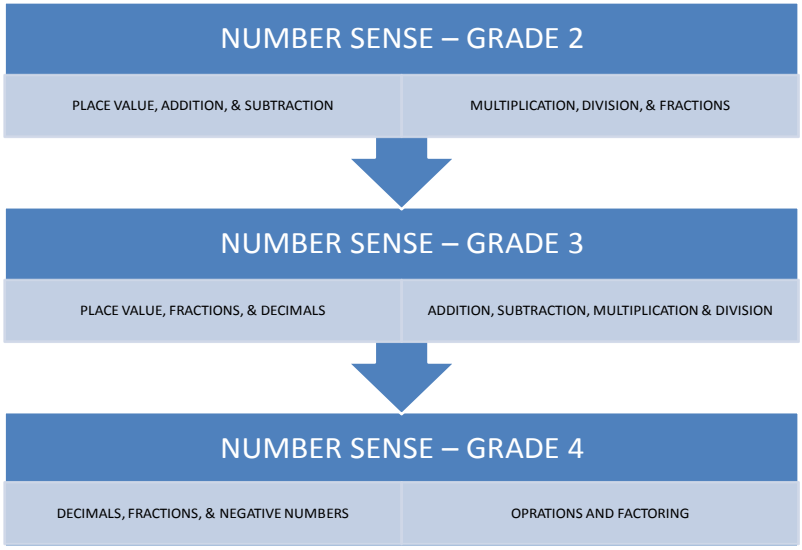


Figure 4: Number Sense Grade 2 - 4

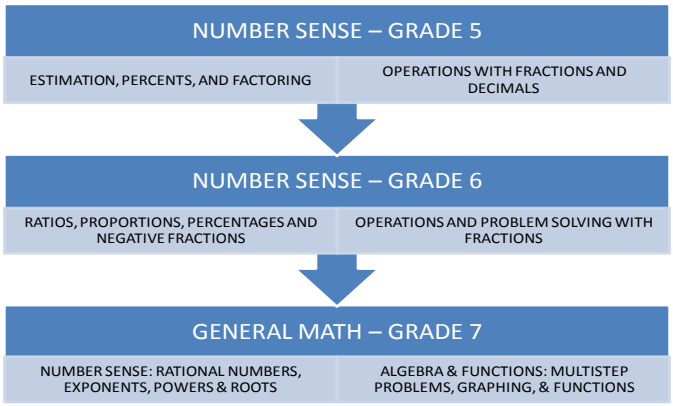


Figure 5: Number Sense Grade 5 - 7

previous instruction to expand their knowledge of mathematics. This process culminates in the Grade 7 where students must perform multiple operations and extrapolate their knowledge to perform more complex operations before entering Algebra 1 in Grade 8. Along with the growth in complexity of the number sense strand, students are constantly exposed to the fundamentals of algebra and functions (by applying specific rules and procedures) which should provide the foundation for students to perform at acceptable levels in Algebra 1.

Mathematics instruction in Grades 2 – 6 is a duel track approach to provide the basic mathematical skills to students and to familiarize them with rules and procedures (algebra) allowing to advance to more complex mathematical capabilities needed in secondary and

college level programs. For students who do not advance to college level programs, they will have attained, in theory, appropriate mathematical skills to at least pursue some type of vocational career in a community college program and/or deal with daily life issues after completing a high school education.

So this discussion brings me back to my first question: why do significant numbers of students arriving in Grade 9 Algebra 1 lack basic skills in mathematics? The California CST Standards clearly defines what should be taught based on what is tested on the CST in grades 2 thru 7. Textbooks are designed to focus on state -defined mathematics standards and curricula are formatted to meet the class requirements. After the information presented in this section it seems unlikely that such a situation would lead to significant numbers of students performing at below average levels as they progress through the grades; but as the reader will see in the next section, the numbers tell a truly depressing story.

WHAT THE TEST DATA TELLS US

I begin this discussion by looking at the trends shown from actual test data derived from the "California Standards Tests (CSTs**)** Technical Report" for the years 2007, 2008, and 2009. (The report for tests administered during 2010 has not been released as of this writing). The reports are available at the California Department of Education website: cde.ca.gov/ta/tg/sr/technicalrpts.asp. The CST in mathematics and other core courses is a summative assessment of students' level of learning. The scores are presented in several formats: achievement subgroups, by ethnicity, demographics, etc. For my purposes I will address the subgroup classification assigned to students based on their raw scores (the number of questions answered correctly). There are five subgroup categories:

1. Far Below Basic (FBB)
2. Below Basic (BB)
3. Basic (B)
4. Proficient (PROF)
5. Advanced (ADV)

The score or performance level for each subgroup is presented in Table A in the appendix.

In the previous section, I discussed how California State Standards evolve during grades 2 thru 7 for mathematics. Figure 6 shows the distribution of state CST math scores for the spring 2009 administration. The five subgroups are noted on the graph based on their approximate ranges. This graph is representative of data obtained for the previous years 2007 and 2008. When compares the raw data one finds a difference of one to three percentage points in subgroups year-to-year; however, the overall trends are consistent year-to-year. From 2007 thru 2009, students show incremental improvement in performance in grades two thru seven on the mathematics exam. Most students score in the "basic" subgroup as shown in the Figure 6 (as represented by a typical bell curve) with the right and left tells representing "far below basic" and "advanced" subgroups.

Figure 6 shows another interesting detail. Subgroup scores show a pronounced leftward shift from grade 2 thru grade 7. In other words, as students advance through the grades their

CST math scores decrease, in other words, their performance decreases. Some students who tested advanced in grade 2, test proficient in grade 3 or 4. Also the number of students who test "far below basic" and/or "below basic" in early grades increases in later grades; that is their performance, which was already below standard, progressively worsens. These statements are generalities. An exact analysis would require a researcher to track individual students by student identification number from grade 2 thru grade 7; however, the general conclusion would be the same. (I was actually able to do the above exercise for grades 6 thru 9 when given access to a student database which contained three years of test results for my students). Figure 7 illustrates the subgroup performance for grades two to seven on the 2009 math CST.

In Figure 7, the reader can examine each subgroup by grade. For example, students who score "advanced" rise to a peak of 40% in grade 4 and then declines approximately 15% by grade 7. The three subgroups that show growth are "basic", "below basic", and "far below basic". The latter two subgroups are negatives in terms of performance and have a severe impact on overall individual school performance measurements. These data give raise to two interesting questions:

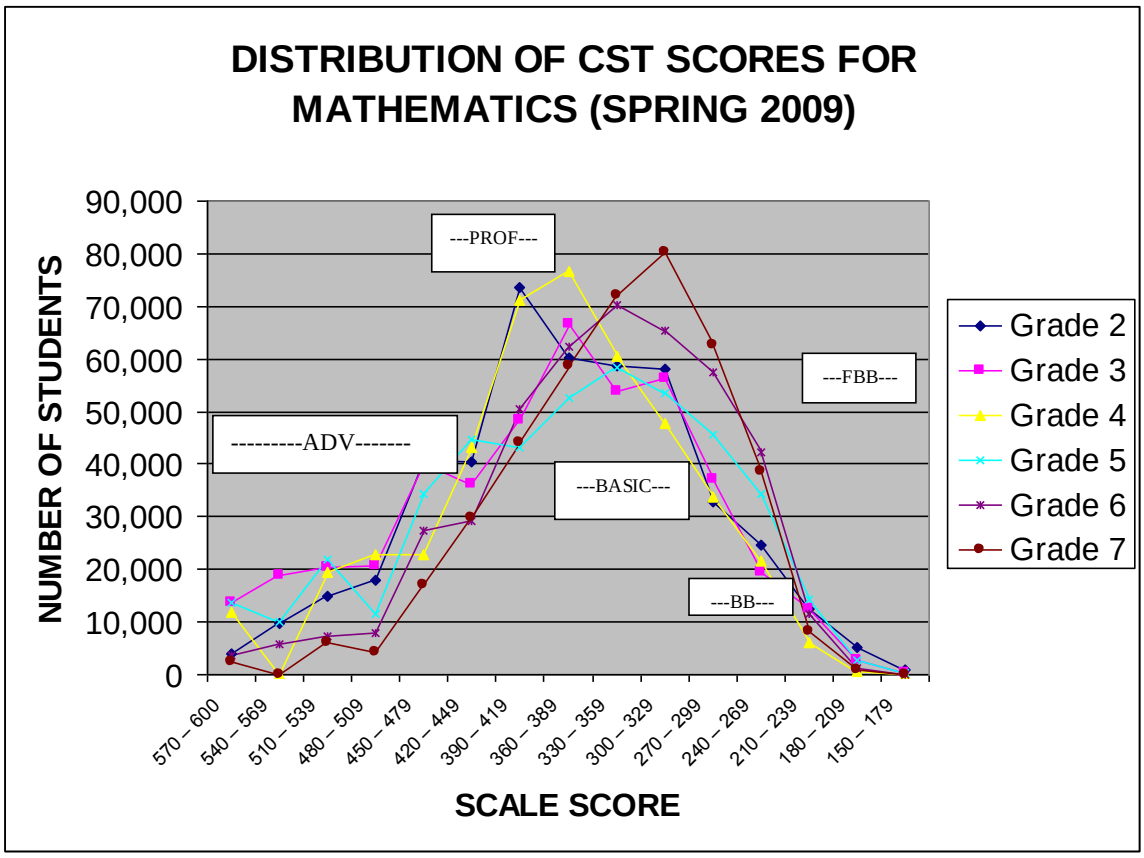


Figure 6: California State Results (Source: 2009 CST Technical Reports)

(1) Are students getting "dumber" the longer they stay in school?
(2) Is the CST more difficult at higher grades than at lower grades?

I am sure there is significant debate over question number (1) and in one sense the answer could be "yes" if one considers situations in which students move to different schools; have ineffective teachers (substitutes) during their time in grades two to seven; or a change in curricula, textbooks, etc during the same period. Obviously there are many reasons for the decline (and in some cases improvements); but is question (1) really the appropriate question to be asking. Instead of asking why the students are "dumber", I believe we should be asking what standards in the CST math exam are causing the greatest difficulty. Or another way of saying it: what is not being taught appropriately so that students can perform at a higher level.

Question (2) on the other hand is answered by the CST creators. The test is designed such that the test questions are considered "middle difficulty" according to statistical analysis and other techniques used in developing the tests. Therefore, if one considers the tests to be "constant" in difficulty year-to-year and by grade level that leaves the issue of subject matter content and preparation, teaching effectiveness and/or technique, student participation, and curriculum changes, etc.

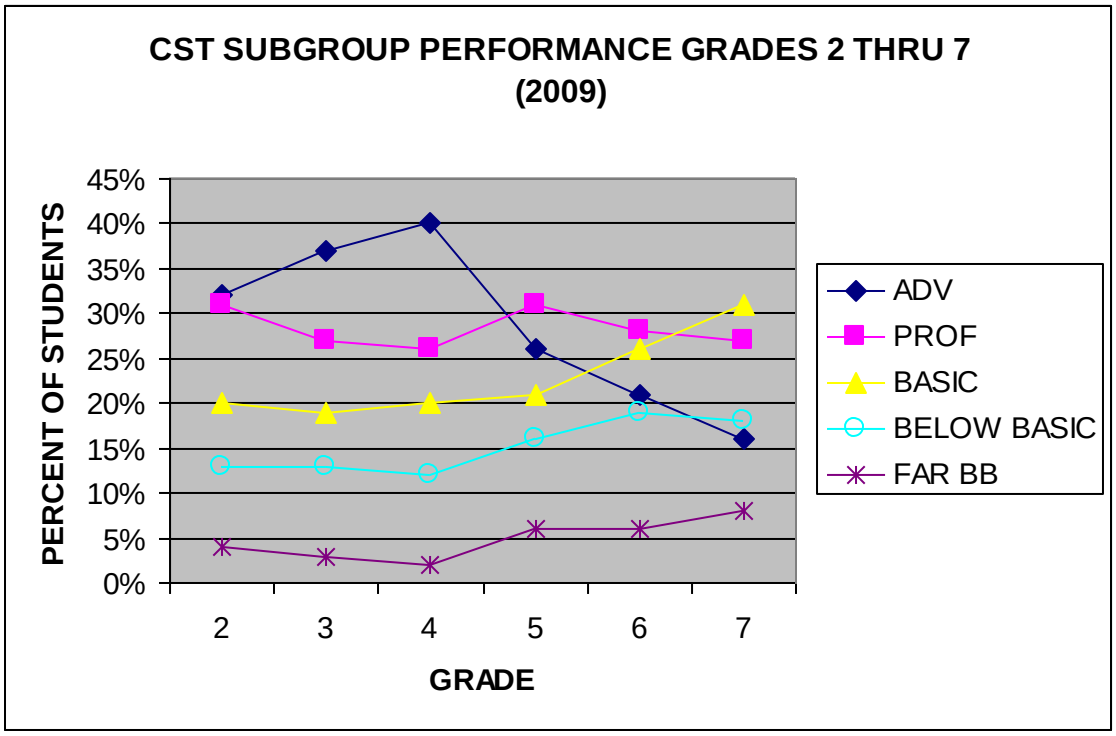


Figure 7: California State Results (Source: 2009 CST Technical Reports)

The data also yields another significant statistical fact. The number of correctly answered questions (the mean raw score) actually declines from grades two to grade seven. Figure 8 shows a graph of the decline in scores. This phenomenon of declining scores continues to a greater extent at higher grade levels in mathematics.

The analysis so far has focused upon grades two thru seven mathematics standards and how students perform using California state data results. We have seen how the curriculum provides a duel track in which students are given/taught the fundamental basic skills and collaterally provide with a growing exposure to algebra rules and procedures. The state data

shows that students tend to reach a peak in performance during grades two to four and then start a slow decline in performance through grade seven as evidenced by declining raw scores and the population changes in subgroups.

Many people may ascribe this phenomena to a "survival of the fitness" or some other form of human behavior. However, this gross description ignores the consequences of high failure rates in mathematics at higher grade levels (eight thru twelve) of many students who test in "below basic" and "far below basic" subgroups. These two subgroups are very important because these subgroups represent most of the potential "dropouts" that rise as these students rise higher in grade level. These two subgroups are among the three subgroups which actually increase in numbers from grades two thru seven ("basic" subgroup is the third).

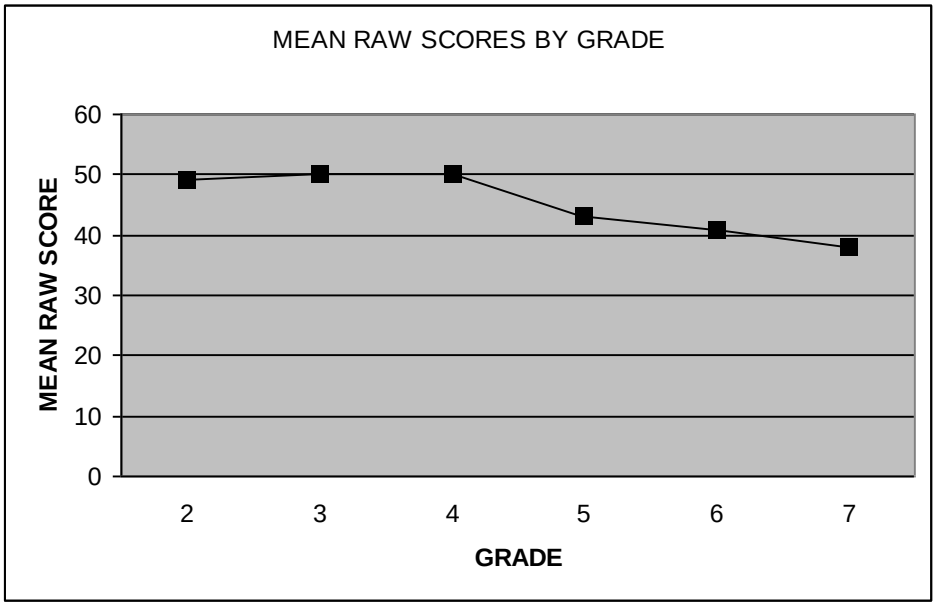
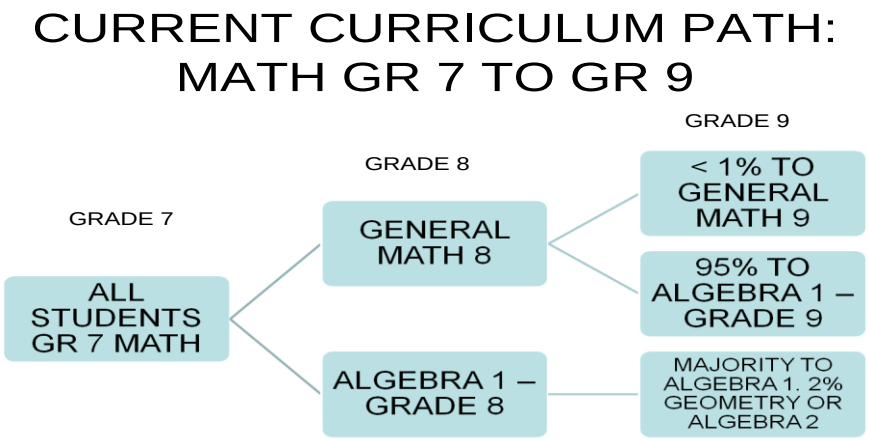


Figure 8 (Source: 2009 CST Technical Reports)

To address these issues using state-level data does not yield plausible solutions. In the next sections I will focus on LUSD and grades seven and eight. Grade seven is extremely important in mathematics education because this grade serves as the "fork in the road" for sending students toward higher mathematics or to dropping out of the academic process. In addition, I will examine how performance on the specific standards identified earlier play an important role in advancing performance levels and show how failure/low performance in specific strands limits future success.

GRADE 7: THE MATH GATEWAY



Grade 7 represents the gateway for students. After students successful complete grade seven they are programmed in grade eight the following year to enroll in General Math 8 or Algebra 1. In this section, I intend to focus on LUSD students and in particular the "below basic" and "far below basic" subgroups. Figure 9 below shows the percentage of students in these two subgroups over the past few years of CST testing according to CDE CST results.

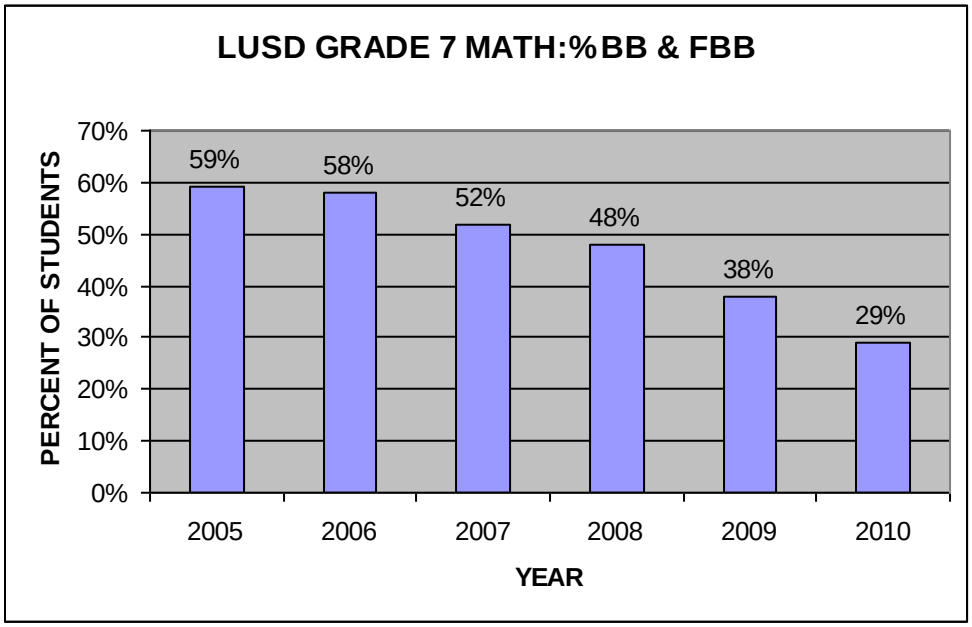


Figure 9 (Source: 2005 - 2010 CST STAR Results)

The chart shows a positive trend for these two subgroups in that the two subgroups are declining district-wide for grade seven. This trend would suggest that these students are being better prepared for grade eight math either, General Math 8 or Algebra 1, than the previous state data showed. This is not a real concern since we are comparing a relatively small population (1100 plus students) to a population of 700,000 students statewide.

Referring to Figure 5, the reader can see that the strands for Grade 7 Mathematics are the same however, the focus is on using the basic skills learned to operate on more complex problem types. The student up to grade seven has been taught the math concept and given the algebraic rules that govern how those complex problem types are solved. For example in grade three, students are taught what "fractions" are and what they represent physically in some cases. In Grade 7 Mathematics, the student is taught that "fractions" are now "rational numbers" and that these numbers can be used in calculations, equations, and various types of functions. Figure 10 shows the performance of General Math 7 students during the 2007 to 2010 time period. The graph mirrors previous results from the state database and shows that General Math 7 students are improving year-to-year. In fact the graph shows that 2010 has been a year in which tremendous improvement was shown in all subgroups.

Based on the data presented in this chart one would expect to see improving performance by a large percentage of these students as they progress to General Math 8 and Algebra 1(grade 8) the succeeding school year. Unfortunately the following year's performance produces mixed and negative results.

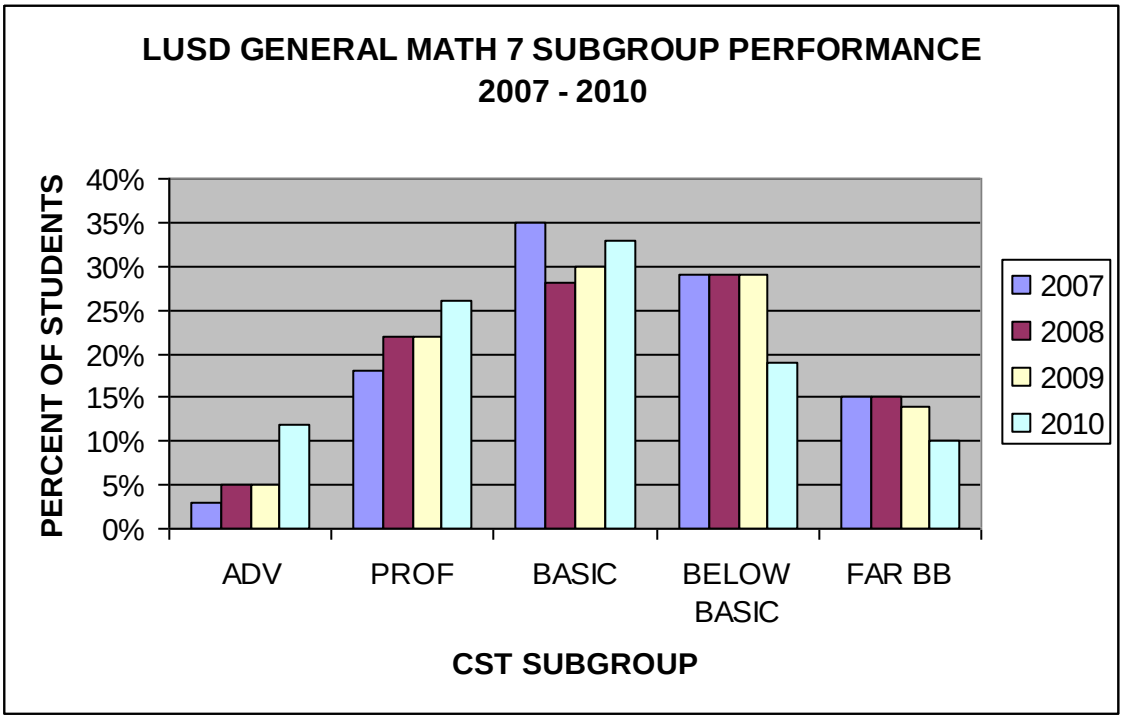


Figure 10 (Source: CST Technical Reports 2007 – 2009)

The chart below shows what has happened over the past three years in LUSD to student performance during the two transition years when student progress from the seventh to eighth grade in mathematics. Starting in year 2008, the GM 7 CST in math yielded 52% of students testing "Basic" or above and 48% testing "Below Basic" or "Far Below Basic".

COURSE	YEAR	2008			2009			2010		
		TESTED	%BASIC+	%BB/FBB	TESTED	%BASIC+	%BB/FBB	TESTED	%BASIC+	%BB/FBB

GENERAL MATH 7	**1357**	**52%**	**48%**	1241	62%	38%			
GENERAL MATH 8				221	22%	78%	53	15%	**85%**
ALGEBRA 1 8				1088	33%	67%	1134	47%	**53%**
ALGEBRA 1 9							**1008**	**26%**	**74%**

These students when divided between GM 8 (221) and Algebra 1 (1088) in the eighth grade (2009) performed worst than the previous year. The 2009 results saw 78% of GM 8 and 67% of Algebra 1 students performing at the BB/FBB levels. The same pattern holds when you examine the year 2009 for GM 7 and the results for 2010 in GM 8 and Algebra 1. The number of BB/FBB students dramatically outnumbered the "Basic" and higher subgroups 85% (GM 8) and 53% (Algebra 1), respectively.

Taking the analysis one further step, consider year 2010 for Algebra 1 Grade 9. During that school year 1213 students enrolled in mathematics in LUSD with over 83% (1008) of them enrolled in Algebra 1 with the remaining students enrolled in Geometry or Algebra 2. From this group, 74% tested BB/FBB. The reader should note that students taking Algebra 1 in grade nine are in many cases repeating Algebra 1 from grade eight. Some are repeating because of failure in grade eight and others are repeating the course because of class programming decisions even though they have passed the class with a grade of "C" or better in grade eight. (The data results on repeating algebra will be discussed in the next section).

So there seems to be a pattern of fifty to sixty percent of Algebra 1 students performing at the "BB" or "FBB" level in grades eight and later. The question is can we identify what is causing the low scores or what part of the standards defined by the state are not being adequately learned/taught etc. Focusing again on the Grade 7 CST in mathematics, Figure 11 shows a plot of subgroup performance comparing mean state data for the past three years with LUSD 2010 data. (An average was taken of state results 2007 to 2009 and used as a baseline for state 2010 data. In Figure 11, the technical report for the 2010 CST was not available at the time of this document's preparation). Figure 11 shows that LUSD Grade 7 students scored within 4% to 6% in all subgroups when compared to state results.

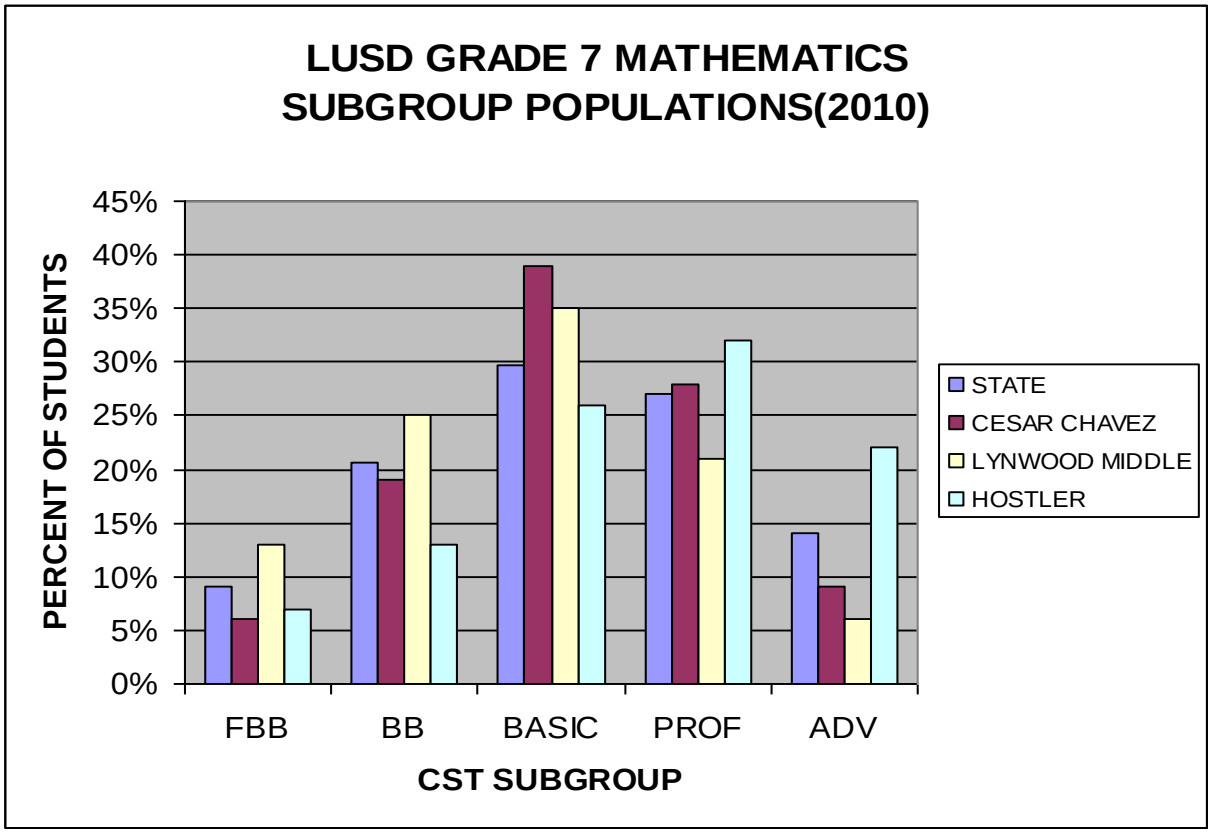


Figure 11 (Source: 2010 LUSD Student Lists Summary)

In fact Hostler Middle School outperformed state averages in all subgroups and is achieving at a higher level compared to the two other LUSD middle schools.

Using Hostler Middle School as a baseline, the next phase is to examine the results of the Grade 8 Algebra 1 CST. The table below shows the difference in subgroup scores for students

Result	GRADE 7: 2009	GRADE 8: ALG 1@ 2010	CHANGE
MEAN SCALE SCORE	**338**	**297**	**-39**
% ADVANCED	**14%**	**6%**	**-8%**
%PROFICIENT	**27%**	**10%**	**-17%**
% BASIC	**28%**	**20%**	**-8%**
% BELOW BASIC	**19%**	**37%**	**+18%**
% FAR BELOW BASIC	**12%**	**26%**	**+14%**

at Hostler over a two year period. In spring 2009, the mean scale score on the Grade 7 math CST was **338** (a score between "Basic" and "Proficient"). In spring 2010, essentially this same group of students (362 in 2009 versus 351 in 2010) sat for the Grade 8 Algebra 1 CST. The mean scale score was 297 (slightly below the "Basic" level). The rest of the table shows the difference in subgroup populations between the two test groups. The reader will note that "positive" subgroups ("Basic" and above) all declined while the "negative" subgroups ("Below Basic" and "Far Below Basic") all increased.

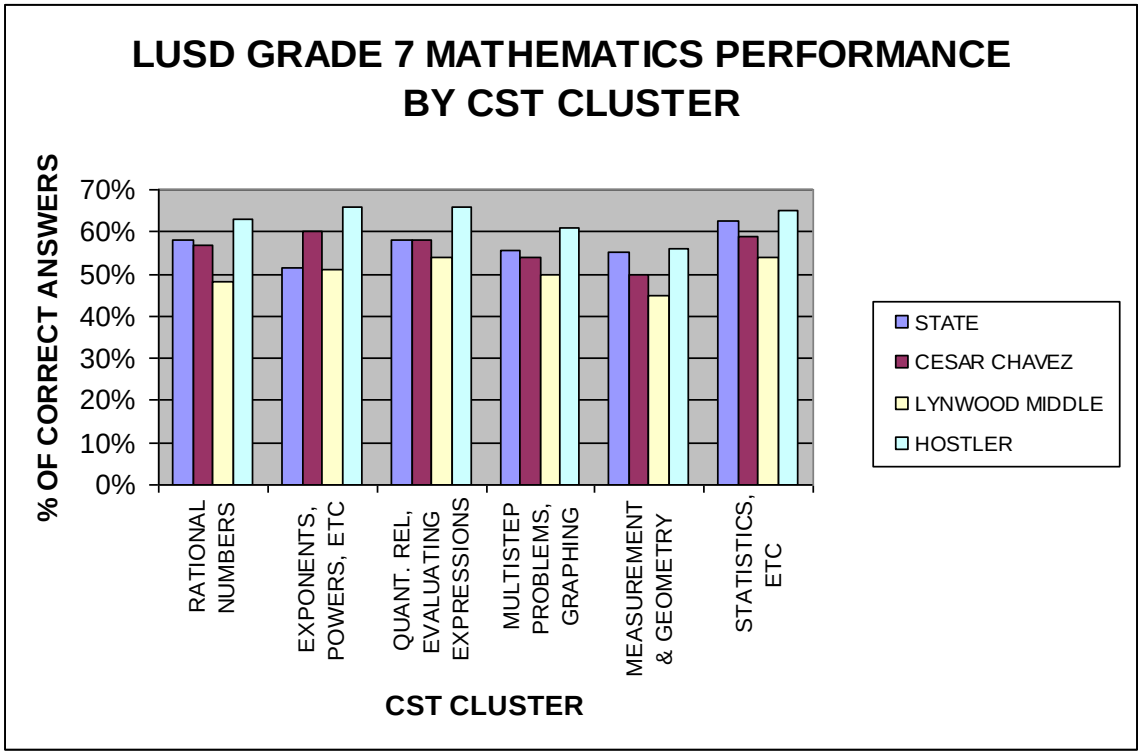


Figure 12 (Source: 2010 LUSD Summary STAR Results)

The 2010 CST for Grade 7 mathematics showed that **32%** and **22%** of Hostlers' seventh graders scored proficient and advanced, respectively, both numbers exceeded the state's averages for the past four years. The key factor in achieving such high scores is that the school scored very well on the five clusters that comprise the Grade 7 CST. All of Hostlers' students averaged from **55%** to **65%** correct answers on the five strands of the mathematics CST (Grade 7) once again exceeding the state and district averages. Figure 12 shows the results comparing Hostler to other middle schools and the state average. Once again Hostler surpasses the other entities.

Recall that students receive a steady exposure to algebra fundamentals from grade 2 thru grade 7 and the standards progress in scope and difficulty each year leading to Algebra 1. Figure 13 compares performance of the three middle schools and state data for Algebra 1, 2010. In this figure Hostler's subgroup performance drops radically. Their mean scale score on the Algebra 1 CST is **297 (Grade 7 math equaled 360)** while Lynwood Middle School's score is **335 (Grade 7 math equaled 319).** Hence in grade eight with essentially the same student population, high scores from grade seven declined at Hostler and improved at Lynwood Middle. On the other hand, Cesar Chavez shows the same pattern as Hostler between the two grades with Grade 7's mean scale score 338, and Grade 8 Algebra 1, 312 and remained in "Basic" region. As can be seen from comparing Figure 11 with Figure 13, the bell-shaped curve in Figure 11 is skewed slightly toward the right ("Basic" and above region) for Grade 7 mathematics; however, for Algebra 1, the graph skews to the left ("Below Basic" and below region) indicating that a significant number, more than 50%, of entering eighth grade students are adequately for Algebra 1 as demonstrated by the spring CST results.

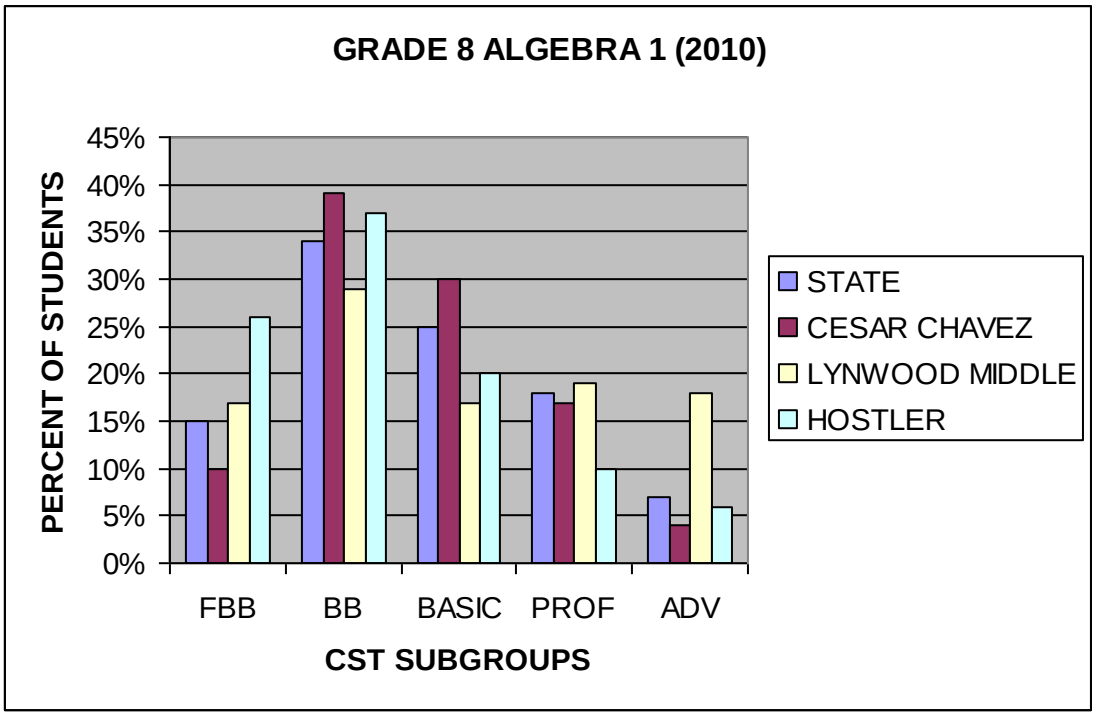


Figure 13 (Source: 2010 LUSD Summary STAR Results)

What Do Performance Scores Tell Us?

Up to this point, I have examined data concerning the performance of students in grades two thru eight in mathematics. My goal has been to answer definitely why students arrive in grades eight and higher unable to perform basic mathematical operations at a "basic" or above level. The data thus far has shown the extent of the problem both at the state, district, and school site levels. The data is telling educators that a pool of students exists who are incapable of performing at acceptable levels in mathematics under the current system because they are not adapting instruction to fix the growing deficiencies. This warning is presented to us by the numbers of students who drop from "advanced" to lower subgroups as well as when students perform at the "below basic" levels and stay there or worse year after year. To explain this situation or warning that is presented to us, I will examine what students should learn in three specific grades: fourth, seventh, and eighth which are essential in a student's progress up the scale in mathematics. Student progress is described in terms of "performance level descriptors" (PLD) defined by a CDE report "Development of Performance Level Descriptors for California Standards Tests (CSTs) and the High School Exit Exam (CAHSEE)" published February 2007.

GRADE FOUR PERFORMANCE LEVEL DESCRIPTORS

Grade four, based on state and district data, represents a turning point in the achievement or performance goals of students. At this juncture students begin to decline in the PLDs for all subgroups in mathematics instruction. To better understand these phenomena, I have created a table which shows what grade four students are expected to know according to the PLDs as demonstrated by their performance on the math CST. From this table the reader can see clearly what the deficiencies are represented by each subgroup. The table will represent four of the five

subgroups. The subgroup "far below basic" is obviously a subgroup of students who have met none of the performance levels. The analysis will focus on the "Number Sense" strand since is essential to all grades and I contend offers the most glaring example of declining student performance.

Grade 4 MATHEMATICS PLD @ NUMBER SENSE

SUBGROUPS CHARACTERICS	ADVANCED	PROFICIENT	BASIC	**BELOW BASIC**
1. Knowledge of operational procedures with whole numbers, fractions	Yes	Strong with whole numbers	Some understanding of fractions, decimals	**Compute multi-digit addition only**
2. Demonstrate understand of factors & place values	Yes	Knowledge of equivalent notations	Some understanding	**Identify fractional part, limited decimals**
3. Demonstrate how to use algebraic formulas	Yes	Yes	Some Understanding	**Limited or minimal**
4. Know and use foundational algebraic concepts	Yes	Solve simple algebraic equations	Limited equation solving ability	**Little Understanding**
5. Knowledge of 2 & 3 dimensional shapes	Yes	Partial: determine area/perimeter	Limited: area by counting grids	**Visualize 2-dimensional patterns**
6. Interpret models and displays, determine results	**Yes**	**Interpret 2-value data**	**Identify some representations**	**May identify some representations**

From this table one can see quite clearly where "Below Basic" students will have difficulty in higher math levels from rows (1) and (2) dealing with number operations and the row describing "foundational algebraic concepts". This table tells us that "below basic" students lack the following:

(1) basic computational skills of addition, subtraction, multiplication, and division
(2) do not understand the concepts of the "number line" and the concepts of decimals and place values
(3) they are unable to solve formulas
(4) have not learned the fundamental/foundational rules of algebra
(5) they do not understand graphs and other representations used to model data, etc.

It should be obvious to the reader that bullet (1) is essential for a student to begin to use the concepts and operations necessary for bullets (3) and (4). Before concluding this section, let us examine how many students are defined by the PLDs above. According to the results of the 2010 math CST for LUSD, **1,133** were tested for Grade 4 mathematics. Of that number 19% tested "Below Basic" and "Far Below Basic" which means ***215*** students are lacking the skills to

advance adequately in mathematics at the end of grade 4; but as we all know, they are in most cases summarily advanced to grade 5.

The reader may refer to the document named above for a more thorough description of all the PLDs for all grade levels and strands.

GRADE SEVEN PERFORMANCE LEVEL DESCRIPTORS

In an earlier discussion, I called Grade 7 mathematics the "gateway" to higher mathematics because this grade level represents the dividing point between students ready for algebra (and hopefully higher mathematics) and general math for those who have demonstrated a lack in basic skills entering grade eight. Grade 7 mathematics is often called Pre-algebra in many schools and the standards taught during that grade represent an end to the development of foundational algebraic concepts. Once a student is enrolled in Algebra 1(eighth grade) he/she is expected to expand upon the foundational concepts to solve more complex problems. In 2010, according to the CDE' STAR results of **1,145** seventh graders tested, 29% or 332 testing "Below Basic" and "Far Below Basic".

The summary PLDs for the four Grade 7 subgroups are outlined in the table below. From the table it should be obvious that a student who tests "Below Basic" on the seventh grade math CST will have significant trouble in an Algebra 1 course. Such students are unable to competently compute and recognize problem types, or specifically, understand what procedures to use to attempt a solution. Their lack of understanding of rational numbers, algebraic expressions and variables will impede solving multi-step equations, formulas, and the process of converting numbers from one form to another.

Given the above characteristics, how does it make any sense for administrators to place incoming eighth grade "Below Basic" mathematics students in Algebra 1? In answer to the question, *it does not*, and the answer is borne out by CST results data. If we return to results from 2009, we see the folly of the decision to program students in this manner. According to the 2009 CDE STAR results, **1,241** students took the Grade 7 math CST in LUSD.

Grade 7 MATHEMATICS PLDs - SUMMARY

SUBGROUPS CHARACTERICS	ADVANCED	PROFICIENT	BASIC	**BELOW BASIC**
1. Understand rational numbers exponents, and percents	Yes	Strong with rational numbers and operations	Limited understanding of rational numbers	**Minimal understanding of rational numbers**
2. Know basic elements of pre-algebra: expressions and variables	Yes	Solve 2-step equations, infrequently divide monomials	Apply the identity and distributive properties	**Limited understanding of how to translate verbal and expressions**
3. Understand geometric concepts- Pythagorean Theorem	Yes	Able to use formulas and use measurements systems	Some Understanding of geometric properties	**Limited or minimal understanding**

4. Able to solve problem in a wide variety of contexts	Yes	Pull information out of word problems	Some understanding of applying number sense to real-world problems	**Little Understanding**
5. Able to read and interpret data representations	Yes	Understand common terms and concepts	Beginning understanding of graphs and features	**Limited or minimal understanding**
6. Use exponents rules to simplify rational numbers	**Yes**	**Extract the root of perfect squares**	**Multiply and divide rational numbers**	**Basic foundations of exponents**

Of this number **38% or 475 scored** "Below Basic" and "Far Below Basic". Moving to 2010 results, the same source shows that a majority of the students from grade seven (2009) were enrolled in grade eight Algebra 1 (2010). The spring 2010 results showed 53% (601 students) "BB/FBB" as shown in the chart below. I will leave it to the reader to decide if that programming decision made sense for these students.

	STUDENTS	BELOW	FAR BELOW
COURSE	TESTED	BASIC	BASIC
GM 8 2010	53	42%	43%
G-8,ALGEBRA 1	1,134	35%	18%

Obviously there were changes in the student population, but it can be safely assumed that most of the grade seven students in the district continued on to grade eight in the district. The fact that 601 students of 1,134 scored poorly on the states' standardized assessment should indicate that there exist significant problems in mathematics instruction, programming, and student mastery of the content. In addition, how many of these 601 students received passing grades in Algebra 1, or conversely they failed the course and were placed in Algebra 1 in the ninth grade still carrying the same deficiencies they showed in Grade 7 (Pre-Algebra) and Grade 8 Algebra 1.

To underscore the impact of the programming decisions that have been made in LUSD, Figure 14 shows the results on the Grade 8 Algebra 1 CST for the years 2006 thru 2010. The figure shows that for the past four years (2007-2010) 50% of the students have been scoring

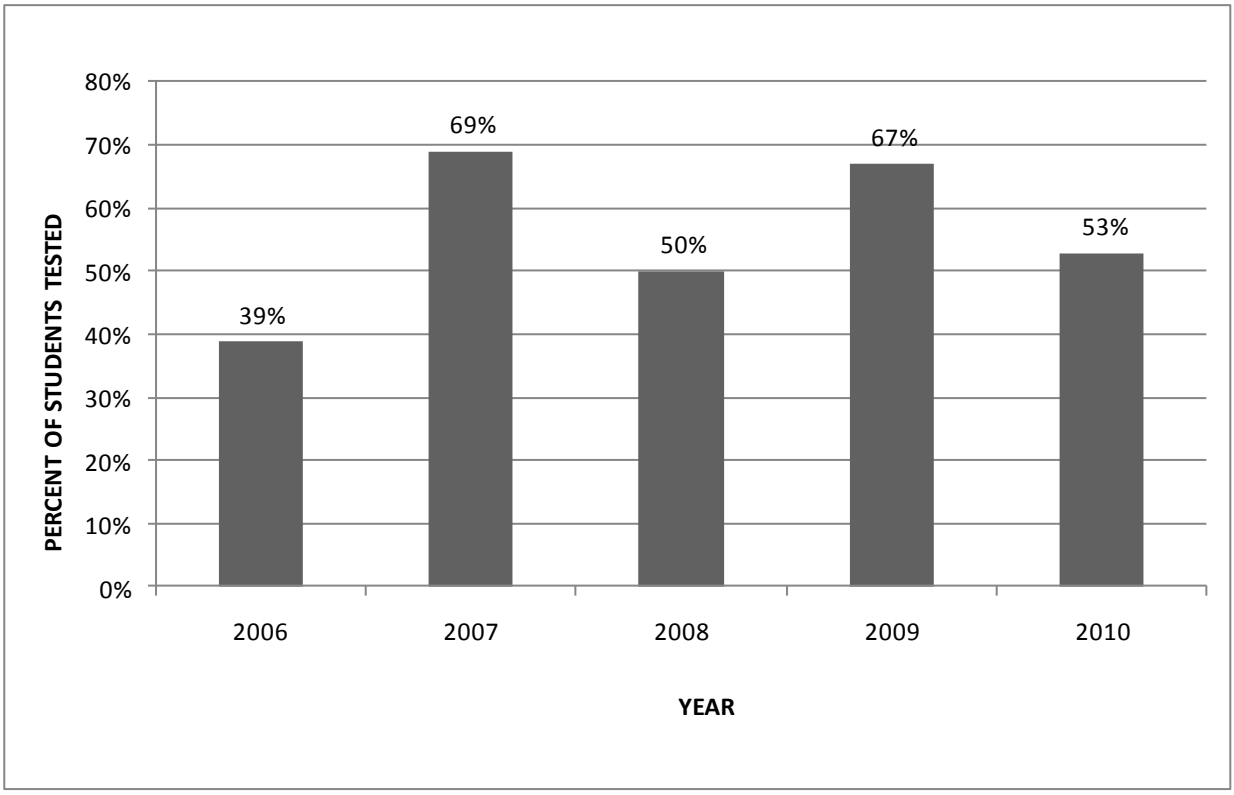


Figure 14 Percent of BB and FBB Students Algebra 1 Grade 8, LUSD

"BB" or "FBB"on the Algebra 1 CST in the eighth grade (Source: CST STAR results 2006 to 2010, LUSD). Short of conducting an in-depth transcript analysis, many of these students repeat Algebra 1 in the ninth grade. Unfortunately, many of these students continue to perform poorly Algebra 1 into their later years of high school (tenth, eleventh, or twelfth grades).

Now, let's examine what the PLDs are telling us about low performing Algebra 1 students (BB and FBB). The fact that a student scores poorly on the CST does not mean that the student failed the course, because as most educators know there is a distinct difference between a summative assessment like the CST and weekly classroom exams and quizzes. A low score on the CST, assuming the student tried his/her best on the exam, tells us that the student has severe deficiencies. I contend that the build up in deficiencies from earlier grades manifest themselves fully when the student arrives in Algebra 1. By comparing the PLDs for three subjects I believe the reader can fully understand the problem and see how it tracks through the lower grades to Algebra 1. The table below compares the summary PLDs for the "Below Basic" subgroup for Grade 7 math, General Math (8^{th} and 9^{th} grades), and Algebra 1.

CHARACTERISTICS OF BELOW BASIC SUBGROUP

CST STRANDS	GRADE 7	GENERAL MATH (8 & 9)	**ALGEBRA 1 (GRADE 8)**
NUMBER SENSE: RATIONAL	Minimal understanding of	Minimal understanding of basic operations:	**Some understanding of**

NUMBERS	rational numbers, exponents	fractions & decimals	**number properties**
ALGEBRA: EXPRESSIONS AND VARIABLES	Inability to translate between verbal and algebraic expressions	Minimal understanding of pre-algebra concepts(variables) and problem solving	**Minimal understanding of foundational topics of Algebra 1. Difficulty manipulating expressions**
***GEOMETRY*:** FORMULAS, DIMENSIONS, ETC	Minimal understanding of aspects of geometry	Minimal understanding of aspects of geometry	**May recognize parallel and perpendicular lines**
FUNCTIONS & DATA ANALYSIS	**Understand basic concepts of statistics**	**Some understanding of probability**	**Little understanding of functions and graphs**

From the table above it should be apparent that students scoring in the "BB" subgroups beginning in Grade 7 will undoubtedly have difficulty moving to the higher math levels. In Grade 7 for instance the most disturbing characteristic is the "minimal understanding of rational numbers". This circumstance alone should indicate that a Grade 7 student is definitely suspect in terms readiness for entering Algebra 1 in the eighth grade. And as has been shown in the previous tables, the results of the CST have borne out the result of such decisions.

The reader will note that there have been no PLDs defined for the "FBB" subgroup. Their skills are low and from the data show minimal improvement grade to grade. Unfortunately data on CST tests in all core subjects show the "BB" and "FBB" subgroups increasing in size through grades K – 11.

In concluding this section, can I say why perform poorly on the Algebra 1 CST and/or why they fail Algebra 1. I believe the empirical evidence is present which allows one to conclude that the poor performance is specifically due to three factors:

1. Low performing students (BB/FBB) in Grade 4 are exhibiting deficiencies in basic computational skills and do not understand foundational algebra concepts.
2. By Grade 7, BB students have not yet come to understand rational numbers and operations. They also are unable to solve algebraic expressions and have trouble with verbal expressions.
3. For those students who are placed in General Math 8 before going into Algebra 1 (presumably in Grade 9), the BB student has minimal skill in basic math operations. They also exhibit poor problem-solving ability and do not understand pre-algebra concepts.

The three factors described above have a common denominator, "Number Sense"; this area is of utmost importance for student math success because students must not only understand numbers but how to compute, group, analyze, and transform numbers into various forms. Algebra provides the rules and procedures but if a student doesn't understand how to compute,

rules only serve to confuse and frustrate; something I have seen many times with low performing students in Algebra 1.

The data and issues developed in this section clearly show that the current "system" of educating math students from grades two thru eight has shortcomings. Significant numbers of students from grades four onward are not learning the math skills ("Number Sense") necessary to become proficient in algebra and as a result continue to fail; and in extreme cases, students' inadequacies in mathematics and other courses leads to dropping out of high school.

The reasons for the shortcomings are many but perhaps administrators should revisit concepts as student development and the types of learning modes, such as: visual, auditory, and etc that are inherent in growing human beings. "Teach to the test" modalities and "pacing plans" are clearly not working as evidenced by the number of low-performing students. Students' commitment to learning and teachers' understanding and recognition of when a student has reached a level of mastery of the content which satisfies high, measureable performance criteria needs to become the focus in teaching mathematics. All students do not learn in the same way; therefore we cannot teach them all the same way.

In the last section, I will look at the efficacy of repeating Algebra 1 for students who have failed. I think the data will show that repeating Algebra 1 two or even three times for high school students has diminishing impact on student achievement.

RETAKING ALGEBRA 1: GOOD OR BAD IDEA?

In the typical high school class in Algebra 1, it is not unusual to have students from the tenth and eleventh grade in the class. These students for some reason or the other have failed one or both semesters of Algebra 1, previously; however one circumstance is always present these are normally "BB" and "FBB" students. The efforts of these students to obtain passing grades is necessary for them to meet the state's graduation requirements, but the current system of re-enrolling these students does significant harm to the district and individual high school's performance (API and APR).

The reason that a school's performance is lowered by the process of retaking Algebra 1 is simple. Students in Grade 9 and above taking Algebra 1 score poorly on the Algebra 1 CST as compared to those in Grade 8. Figure 15 shows the results from the 2010 LUSD CST for Algebra 1. The best performance on the exam occurs in the ***eighth grade*** when most students take Algebra 1 for the first time. Additionally, the ***mean scale score*** (i.e. raw scores-the number correct) also declines after Grade 8. It must be remembered all grade levels take the same Algebra 1 CST exam. The exam is not grade-specific; hence the students who were performing BB/FBB in Grade 8 could still be BB/FBB in Grade 11; the only difference is that the percent of the class is larger because there are fewer students (eleventh graders) taking the exam as compared to ninth graders.

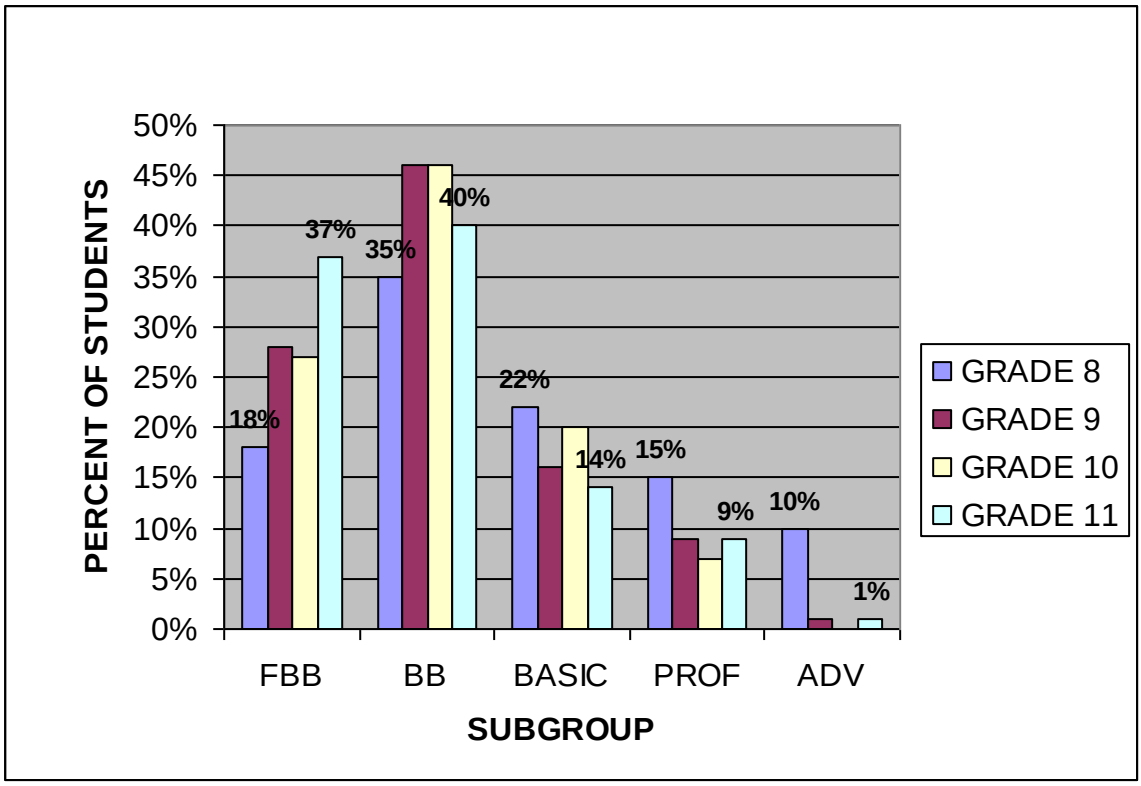


Figure 15: Grade 8 thru Grade 11 Algebra 1 CST Results (2010 LUSD)

In addition, overall performance (declining mean scale scores) and content area performance declines each time a student re-enrolls in Algebra 1 as shown in Figure 16 where the percent of correctly answered questions is plotted versus the content area. Recall the two key content areas are "Number Sense" and "Graphing & Systems of Linear Equations" for Algebra 1, these content areas are most closely related to grades two thru seven preparations for Algebra 1. Subgroups "BB" and "FBB" tend to increase in size (population) as a percent of test takers when repeating Algebra 1 and grossly outnumber the size of other three subgroups. In Figure 16 the pattern repeats itself as in the subgroup plot of Figure 15: the best performance occurs when students are initially enrolled in Algebra 1 in Grade 8.

Because of this data I believe that a better alternative needs to be developed to help students who must repeat Algebra 1 because of low scores on the CST or because they have failed the course. Lynwood High School during the 2010 and 2011 school years summarily placed incoming ninth grade students who score poorly (BB/FBB) on the CST in Algebra 1 in a low-level Algebra 1 class which was designed to proceed at a slower pace. In addition, students who had previously failed Algebra 1 were also placed in some of these classes. As a teacher who taught several of these classes, the experiment was a failure. The students demonstrated many of the issues I described previously for BB students. The inability to perform mathematical computations, limited understanding of rational numbers (fractions and decimals), and poor work habits resulted in many students failing. The students, in general, lacked basic math skills.

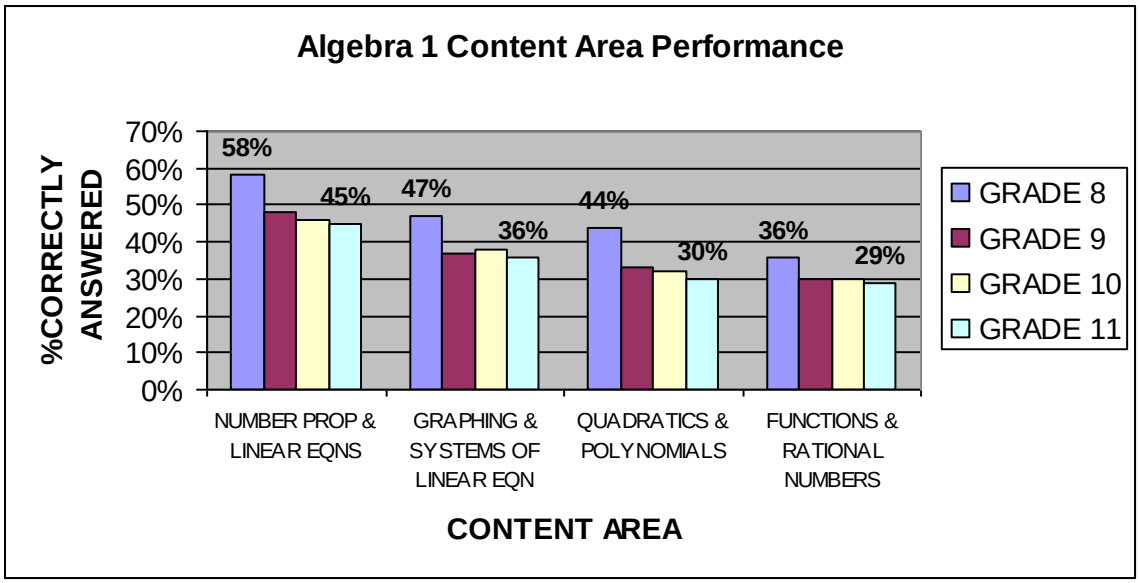


Figure 16: Algebra 1 Content Performance vs. Grade Level (2010 LUSD)

As a result of what I have described above I believe that a separate math course should be created to handle low scoring and repeat Algebra 1 students. At Lynwood High School a course called CAHSEE Math currently exists to assist students who have failed the CAHSEE exam. This course uses the CAHSEE exam as the curriculum and is designed to help students pass the exam. The CAHSEE exam is primarily based on grades 7 and 8 level mathematics; it incorporates the content areas essential for Algebra 1, "Number sense" and "Algebra & Functions". Based on what the CAHSEE exam emphasizes and the content areas essential to passing Algebra 1, a curriculum should be developed which refocuses CAHSEE Math to remediate BB/FBB student deficiencies, as well as, preparing tenth grade or higher students to be successful in an Algebra 1 course without requiring them to take the spring CST in Algebra 1.

SUMMARY AND CONCLUSIONS

Algebra 1 is a mathematical discipline that is an essential course in a student's education. Defined by the state of California as a core course and a requirement for graduation from high school, schools have a duty to ensure that students are well prepared for an Algebra 1 course. Mathematical standards are designed from grades two thru seven to prepare students for this goal. Mathematics curricula define a dual path in which students are taught the essential basic math skills while being introduced during early grades to the foundational concepts of algebra. This process continues until the seventh grade at which point students begin a Pre-algebra (Grade 7 Math) class where all the concepts are integrated into one course in preparation for Algebra 1 in grade 8 in most schools.

This process assumes that students are getting the necessary instruction in basic math skills essential to performing the computations necessitated by algebra rules. State of California results of the CST show how students have performed on these exams. Although the data shows steady improvement in mathematics proficiency statewide, the data also shows that certain subgroups (defined by the CST) are not achieving at levels necessary to meet NCLB goals of

proficiency in mathematics. The number of students who perform at high levels during their early elementary school years declines as the students approach grades 7 and upward while the population of low-performing students increases during that time frame.

The decline in high performing students coupled with the growth in the numbers of low-performing students can be traced to students not mastering the basic skills defined in the content areas of "Number Sense" and "Algebra & Functions". The "Below Basic" and "Far Below Basic" student does not fully understand how to compute and manipulate rational numbers according to the PLDs defined by the CST developers. These students have difficulties in solving simple and multi-step linear equations either with integers and/or whole numbers due to their inability to compute adequately. They also have difficulty in distinguishing between algebraic expressions and equations and applying the correct procedures in evaluating either one. They have minimal understanding of how to graph functions, use exponents, and analyze data representations all of which are necessary to be successful in an Algebra 1 course. These shortcomings are evident in the numbers of students who perform poorly on the math CSTs. During the last four years more than 50% of students in grade eight, Algebra 1 in the LUSD have scored BB/FBB on the Algebra 1 CST (Figure 14).

The performance data signals that administrators and teachers need to rethink the current system of how we teach mathematics. Students learn in many ways and different speeds. Our methods of teaching, strategies employed, pacing, assessing, and intervening need to be rethought and refocused on reducing the BB/FBB subgroups in early elementary through the middle school years. There will never be a hundred percent turnaround but surely reducing the 20% or more of BB/FBB students per year is doable with the goal of reducing *Algebra 1 Repeats.*

Retaking Algebra 1 after a failed class or poor CST does not in most cases benefit the student. Even if the student somehow passes after repeating the class they still lack a firm understanding of basic math skills which is confirmed by scores on the Algebra 1 CST for tenth and eleventh graders. The Algebra 1 student population decreases in grades ten and eleven; however, the number of these students scoring BB/FBB is disproportionately higher (60% to 70%) in these two grades than in grades eight and nine. Students who fall into the low-performing categories need a course which reestablishes a foundation in basic math skills focusing on "Number Sense" and foundational algebra procedures so that the student can progress. Such courses do exist at some schools but are misdirected at "teaching to the test" activities instead of providing well-planned remediation which allows the student to learn how to use and apply mathematical processes and thereby the critical thinking necessary to effectively engage in problem-solving. Repeatedly enrolling a student in Algebra 1 wastes school resources, lowers school performance, and most importantly does not benefit the student.

Finally, Algebra 1 success for a student is based on a structure of learning that must not be shortchanged to be successful. Students who fall outside the structure need immediate and focused remediation in order to get back on track. This requires administrator and teachers to have timely information on a student's strength and weaknesses in mathematics. Remediation must begin in the early grades to have a chance of benefitting the student and lessening the chance of the student "turning off" to school. The current system of programming students based on test results without providing meaningful interventions and a structured approach does not benefit the student and indirectly hinders a school's performance ratings. *Intervention systems must be developed at the early grades because once a student has left elementary school it is* ***too late.***

REFERENCES

1. California Standards Tests (CSTs) Technical Report Spring 2007 Administration, Feb 2008; Chapter 5, *Score Reports, Table 5.B.1,etc*

2. California Standards Tests (CSTs) Technical Report Spring 2008 Administration, Mar 2009; Chapter 5, *Score Reports, Table 5.B.1,etc*

3. California Standards Tests (CSTs) Technical Report Spring 2009 Administration, Mar 1, 2010: Chapter 6, *Performance Standards, Table 6.1 etc*

4. Development of Performance Level Descriptors for the California Standards Tests (CSTs) and High School Exit Exam (CAHSEE); Appendix A ,pages A-45 – A-70.

5. California STAR CST Test Results – www.star.cde.ca.gov: Data from 2006 to 2010 for California State Results and Lynwood Unified School District schools.

6. LUSD Student Master List Summary for California Standards Tests 2010.

APPENDIX

The data and all other data presented were compiled from the source documents to support the discussion areas in this paper. The source documents contain much more data which were outside the scope of this paper.

Table A
Scale Score Ranges For Performance Levels - Mathematics

Subject	CST	Far Below Basic	Below Basic	Basic	Proficient	Advanced
Mathematics	2	150 – 235	236 – 299	300 – 349	350 – 413	414 – 600
	3	150 – 235	236 – 299	300 – 349	350 – 413	414 – 600
	4	150 – 244	245 – 299	300 – 349	350 – 400	401 – 600
	5	150 – 247	248 – 299	300 – 349	350 – 429	430 – 600
	6	150 – 252	253 – 299	300 – 349	350 – 414	415 – 600
	7	150 – 256	257 – 299	300 – 349	350 – 413	414 – 600
	General Mathematics	150 – 256	257 – 299	300 – 349	350 – 413	414 – 600
	Algebra I	150 – 252	253 – 299	300 – 349	350 – 427	428 – 600
	Geometry	150 – 246	247 – 299	300 – 349	350 – 417	418 – 600
	Algebra II	150 – 256	257 – 299	300 – 349	350 – 415	416 – 600
	Summ. H. S. Mathematics	150 – 234	235 – 299	300 – 349	350 – 419	420 – 600

Source: 2009 CST Technical Report, Chapter 6, Table 6.l; CDE.GOV

Table B.1
Percent in Proficiency Level 2007 – Algebra 1

GRADES	Number Tested	Mean Scale Score	Std. Dev. of Scale Scores	FBB	BB	BASIC	PROF	ADV
ALL VALID SCORES	738,231	311	61	16%	35%	26%	19%	5%
GRADE 8	238,426	337	68	9%	25%	27%	29%	9%
GRADE 9	269,287	302	50	17%	37%	28%	16%	1%
GRADE 10	138,172	287	43	23%	44%	25%	8%	0%
GRADE 11	70,694	279	40	27%	46%	21%	5%	0%

Source: 2007 CST Technical Report, Chapter 6, Table 6.A.2l; CDE.GOV

Table B.2
Mean Percent Correct-Content Area 2007: Algebra 1

	NUMBER PROP & LINEAR EQNS	GRAPHING & SYSTEMS OF LINEAR EQN	QUADRATICS & POLYNOMIALS	FUNCTIONS & RATIONAL NUMBERS
All valid scores	54%	44%	44%	37%
GRADE 8	63%	52%	51%	43%
GRADE 9	52%	42%	41%	34%
GRADE 10	46%	37%	37%	31%
GRADE 11	43%	35%	36%	30%

Source: 2007 CST Technical Report, Chapter 6, Table 6.A.2l; CDE.GOV

Table B.3

Percent in Proficiency Level 2008 – Algebra 1

GRADES	Number Tested	Mean Scale Score	Std. Dev. of Scale Scores	FBB	BB	BASIC	PROF	ADV
ALL VALID SCORES	742,363	315	67	14%	35%	26%	18%	7%
GRADE 8	247,372	343	74	7%	24%	27%	29%	13%
GRADE 9	272,810	302	50	15%	38%	29%	16%	2%
GRADE 10	131,030	285	44	21%	46%	25%	8%	1%
GRADE 11	65,535	278	41	25%	49%	20%	5%	0%

Source: 2008 CST Technical Report, Chapter 6, Table 6.A.2l; CDE.GOV

Table B.4
Mean Percent Correct-Content Area 2008: Algebra 1

	NUMBER PROP & LINEAR EQNS	GRAPHING & SYSTEMS OF LINEAR EQN	QUADRATICS & POLYNOMIALS	FUNCTIONS & RATIONAL NUMBERS
All valid scores	55%	45%	44%	37%
GRADE 8	63%	52%	53%	45%
GRADE 9	52%	42%	41%	34%
GRADE 10	46%	37%	35%	30%
GRADE 11	43%	35%	33%	29%

Source: 2008 CST Technical Report, Chapter 6, Table 6.A.2l; CDE.GOV

Table B.5
Percent in Proficiency Level 2009 – Algebra 1

GRADES	Number Tested	Mean Scale Score	Std. Dev. of Scale Scores	FBB	BB	BASIC	PROF	ADV
ALL VALID SCORES	753,193	320	71	16%	32%	23%	20%	8%
GRADE 8	261,565	347	77	9%	23%	24%	29%	15%
GRADE 9	276,147	306	56	18%	35%	25%	18%	3%
GRADE 10	124,989	288	46	25%	42%	22%	10%	1%
GRADE 11	61,200	280	44	29%	45%	18%	7%	1%

Source: 2009 CST Technical Report, Chapter 7, Table 7.C.2l; CDE.GOV

Table B.6
Mean Percent Correct-Content Area 2009: Algebra 1

	NUMBER PROP & LINEAR EQNS	GRAPHING & SYSTEMS OF LINEAR EQN	QUADRATICS & POLYNOMIALS	FUNCTIONS & RATIONAL NUMBERS
All valid scores	58%	47%	46%	37%
GRADE 8	65%	55%	55%	43%
GRADE 9	55%	43%	42%	33%
GRADE 10	49%	37%	37%	30%
GRADE 11	46%	35%	34%	29%

Source: 2009 CST Technical Report, Chapter 7, Table 7.C.2l; CDE.GOV

Table B.7
Mean Percent Correct-Content Area 2010: Algebra 1

	NUMBER PROP & LINEAR EQNS	GRAPHING & SYSTEMS OF LINEAR EQN	QUADRATICS & POLYNOMIALS	FUNCTIONS & RATIONAL NUMBERS
GRADE 8	58%	47%	44%	36%
GRADE 9	48%	37%	33%	30%
GRADE 10	46%	38%	32%	30%
GRADE 11	45%	36%	30%	29%

Source: Student Master List Summary 2010, LUSD