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IMPROVING STUDENT SUCCESS IN HIGH SCHOOL ALGEBRA I BY IDENTIFYING SUCCESSFUL TEACHERS AND SCHOOLS

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ABSTRACT

This study examined practices of teachers in Wake County Public Schools (WCPSS) high school Algebra I classes. Regression analyses of standardized state testing results allowed for identification of the most effective and least effective Algebra I teachers and schools. The study used surveys, observations, and focus group interviews to compare and contrast most effective teachers with less effective teachers It found that the most effective algebra teachers averaged 68% of their time on new material daily; averaged seven transitions in ninety minutes; used sustaining feedback; had structured classes with a culture of mutual respect; told their students what to expect on tests and cautioned them about possible errors; emphasized problem solving and processes; and exhibited a sense of humor. These results can be used to motivate teacher and school improvement efforts.

INTRODUCTION

The importance of teachers is recognized by the National Council of Teachers of Mathematics (NCTM) in *Principals and Standards for School Mathematics*, which details requirements of effective teaching, including the requirement to continually seek improvement. "The improvement of mathematics education for all students requires effective mathematics teaching in all classrooms" (National Council of Teachers of Mathematics, Inc. [NCTM], 2000, p. 17). Several studies of student gains on standardized tests from one year to another have found the student's assigned teacher to be the most influential factor (Rivkin, Hanushek, & Kain, 2001; Sanders & Horn, 1994; Sanders & Rivers, 1996; Wright, Horn, & Sanders, 1997).

The importance of teachers in facilitating student success is also recognized by the Elementary and Secondary Education Act of 1965 (ESEA), as amended by the No Child Left Behind Act of

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2001 (NCLB). Under NCLB, every state must develop and implement a plan to ensure that all students will be taught by a "highly qualified teacher" (U.S. Congress, 2001; sec.2101). Margaret Spellings, U. S. Secretary of Education, stated in a letter dated October 21, 2005, "There is also evidence that states are improving the quality of their teaching forces." She wrote that the U.S. Department of Education was committed to the goal of every child being taught by an HQT by the end of 2005-06, and then outlined the actions that would be taken to support states in reaching this goal (Spellings, 2005). Although the acknowledgement of the importance of high quality teachers is widespread and long-standing, defining the characteristics and behaviors that make a "high-quality" teacher remains an elusive goal.

PURPOSE OF THE RESEARCH

The main purpose of this research study was to improve the performance of WCPSS students in Algebra I by implementing a value-added instructional improvement analysis model. There were three specific objectives:

- collect system-specific data to help teachers and district leadership understand current Algebra I instructional practices,
- identify and share best practices in Algebra I, and
- contribute to a series of studies that identify the role of teachers, system staff, or departments in the school improvement process, and identify the practices of effective instruction.

In 2005-06, 87.3% of WCPSS' high school Algebra I students were proficient on the North Carolina End-of-Course (EOC) Algebra I exam. Students entering high school in 2006-07 and following must not only earn an Algebra I credit to graduate but must also pass the North Carolina State EOC exam to graduate (North Carolina Department of Public Instruction [NCDPI], 2005). Consequently, 13% of high school Algebra 1 students failed to meet the state standard. It is of increasing importance that teachers implement instructional practices that ensure all students success because of the importance of passing this course and test.

Success in this study was defined using a multiple regression analysis of the state EOC standardized tests. This analysis generates for each student, teacher, and school a measure of whether their test scores show a level of performance that is either higher, lower, or about what is expected, compared to other WCPSS students, teachers, or schools. A previous study of biology teaching and learning demonstrated that it is possible to indentify teachers and schools that consistently produce more achievement in students regardless of a student's initial skill level.(Haynie, 2006). This study brings value-added meaning to the Algebra I EOC test performance. The classroom practice of the most successful teachers can then be documented to give hope to those teachers struggling with low performers and to challenge the teachers of high performers to even higher academic goals. The school wide practices of successful schools serve as models for school improvement efforts. Unlike most current valued-added models, teacher performance evaluation was not a goal of this study (Braun, 2005; Olson, 2004a, 2004b; Olson, 2005; Sanders, 1998; Tucker & Stronge, 2005). This study demonstrates an innovative use of value-added research for teacher and school improvement thus affecting improvement at the student level.

BACKGROUND

STATE-DEFINED EFFECTIVENESS

In North Carolina, EOC exams are administered in 10 high school subjects, including Algebra I. Each exam is a standardized multiple-choice test written with much input from teachers across the state. Teachers participate in test development in a variety of ways, from writing curriculum to writing and reviewing test items. Each student who takes an EOC test is assigned a scale score based on the number of items correct and the difficulty of items. The scale scores are then converted to one of four levels of performance. Levels III and IV are associated with adequate or higher mastery of course content, and are considered proficient (NCDPI, 2005).

Teachers receive rosters of students' scale scores, level scores, and a 100-point scale score that is averaged as 25% of the final class grade, as required by State Board of Education policy. An average scale score for the class is also reported on each roster. The percentages of students passing each EOC in a school are reported publicly. Teachers judge their own success using these percentages. The scores can also be disaggregated into many subgroups (e.g. students with disabilities (SWD), free or reduced-price lunch (FRL) students, academically gifted (AG) students, etc.).

If 90% of the EOC scores at a school are in Level III or IV, the school is eligible to be labeled a "School of Excellence" by the ABCs of Public Education, the state's accountability program. However, the program has two standards of achievement: the absolute percentage of tests at or above grade level, and the attainment of "expected" growth. The basic assumption of the growth part of the model is that a student should be expected to do at least as well on each EOC test as he or she has done on prior End-of-Grade (EOG) and EOC tests compared to all other students who took the test in the standard-setting year. (The standard-setting year is typically the first year that a test becomes operational and students receive scores for the test.) Each student who is tested and has previous test results is assigned an "academic change" value. A positive "academic change" indicates academic progress, while a negative value indicates a loss of academic progress. The average of all students' "academic change" values across all EOCs is calculated. If it is zero or higher, the school makes "expected growth". If the school makes expected growth, all teachers receive a monetary bonus, regardless of the percentage of students testing at or above grade level. Teachers and schools with academically weaker students can still make "expected growth" regardless of the level performance of students and vice versa. Teachers with high-achieving students do not always produce "expected growth" in their students, but the "expected growth" measure is considered by most teachers to be a fairer measure of success than student proficiency alone (NCDPI, 2006).

Algebra I is a North Carolina high school graduation course requirement. Starting with the entering freshmen class of 2006-07, students are also required to score proficient on the state Algebra 1 EOC exam. In 2004-05, 85.8% of high school Algebra I students in WCPSS scored proficient. The percentage of proficient students at the 17 WCPSS high schools ranged from 68.8% to 93.1%, with two schools below the state average of 76.1%. The average scale scores

across schools ranged from 59.2 to 68.5. Two schools were below the state average of 63.1 (the state average included middle school students). As Table 1 shows, 12 high schools made high growth, four made expected growth, and one was below expected growth in Algebra I on the North Carolina ABCs accountability model. The schools are labeled A to Q, with A having the highest percentage of students scoring at Level III or IV and Q having the lowest percentage. Also note that the school with the highest percentage proficient (school A) is not the same as the school with the highest average scale score (school E).

Table 1
2004-05 Algebra I Outcomes at 17 WCPSS High Schools

School	% at Level III or IV	Average Scale Score	NC Growth
A	93.1%	67.8	HIGH
B	92.9%	67.0	HIGH
C	91.9%	66.4	HIGH
D	91.8%	68.3	HIGH
E	91.7%	68.5	HIGH
F	90.8%	66.0	HIGH
G	90.3%	66.8	HIGH
H	90.2%	65.8	HIGH
I	88.3%	64.4	HIGH
J	87.4%	64.2	HIGH
K	86.4%	63.2	HIGH
WCPSS High Schools[1]	**85.8%**	**64.3**	**HIGH**
L	80.4%	61.8	EXPECTED
M	79.2%	60.8	EXPECTED
N	77.4%	59.5	EXPECTED
O	76.3%	61.0	HIGH
State[2]	**76.1%[2]**	**63.1 [2]**	
P	71.6%	59.0	EXPECTED
Q	68.8%	59.2	BELOW

[1] Only high school students
[2] All NC Algebra I students (high school and middle school students)

WCPSS-DEFINED EFFECTIVENESS

The state provides test analysis software to every district in the state that can be used to run school-level results and results for subgroups of students within the school. The state also posts these disaggregated test results on a Web \site. These analyses, however, are limited to average scale scores and percentages of students tested who attain proficiency. Although these statistics provide useful information to teachers and principals, WCPSS evaluators felt that other analyses of student achievement data could present a more useful picture of the success of teachers and students. While these measures serve as a valid way of reporting how teachers and schools are succeeding, WCPSS has developed more fine-grained methods to determine which schools are getting the most growth with students *in comparison to other WCPSS schools*. Identifying the schools and teachers that are producing the highest performance in students at varying levels of preparation is necessary in order to share best practices within the district and motivate school improvement efforts.

Since the early 1990s, WCPSS has used a multiple regression analysis on state tests and has generated an effectiveness index for each school that ranks the schools within WCPSS by their effectiveness with the students who attend their school. The regression analysis creates a prediction model by using the current year's test scores as the outcome and previous state test scores as the predictors. The analysis also takes into account each student's special program status (level of service, e.g. self-contained), FRL status, and AG status, as well as the percentage of FRL students in the school. A residual score is calculated for each WCPSS student who took the test and had previous test scores predictors. The residual score for a student is the difference between the student's actual score and the score that the regression analysis model predicted given the student's previous test scores and program characteristics. These residuals give a measure of how students performed compared to other similar students (e.g. students with the same previous test scores and program identifiers) in WCPSS. Figure 1 gives a graphical visual of the regression analysis with three of the many possible lines. It shows that the predictions are dependent on the previous EOG and/or EOC scores and also the program characteristics of the student such as an AG student or a SWD student in a resource setting who is also a FRL student. The middle line could represent students with no identifiers (e.g. typical students).

Figure 1

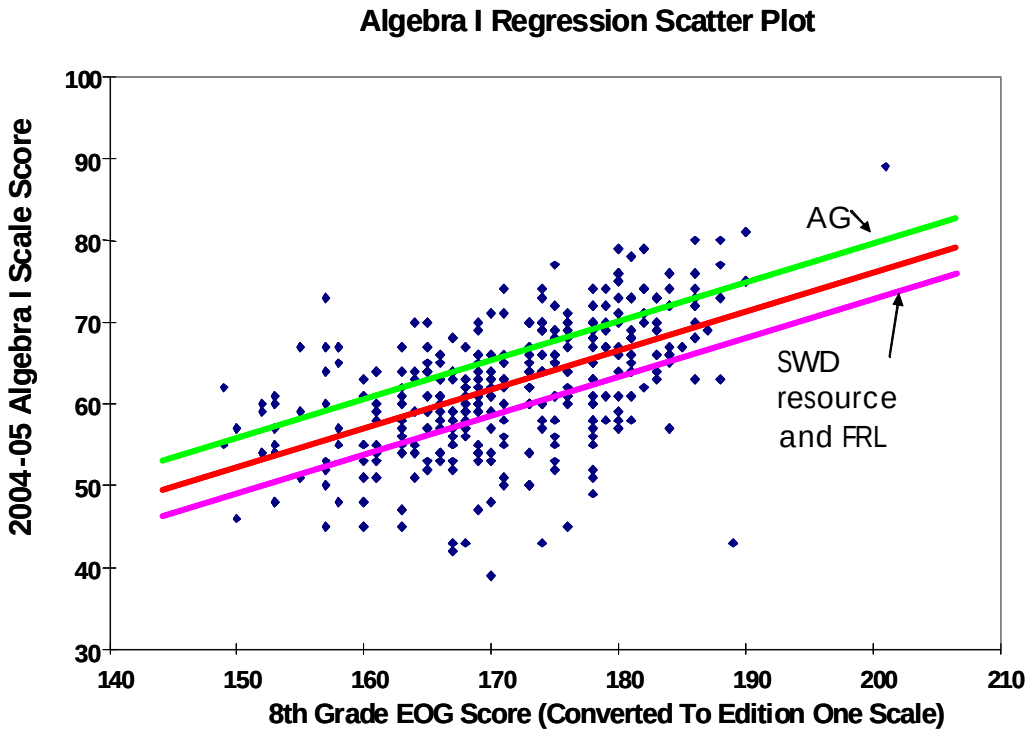
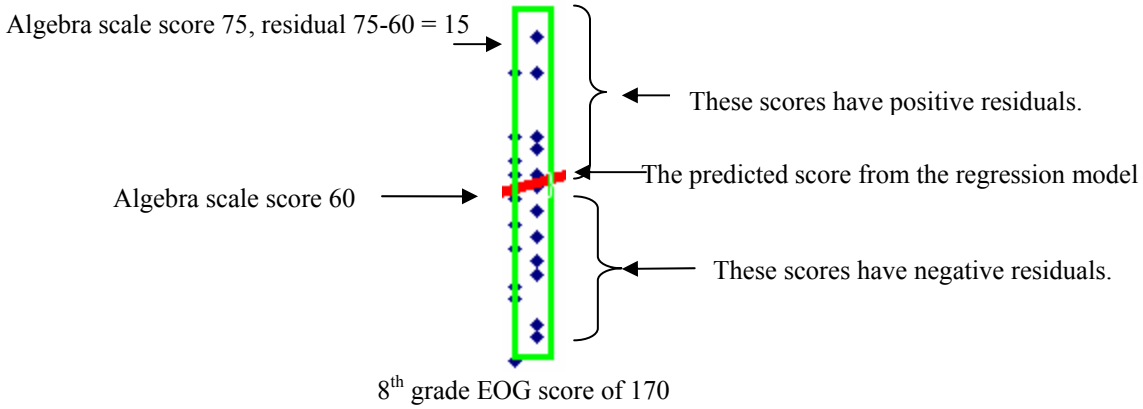


Figure 2 shows one vertical slice of the regression model for the students whose prediction line is the middle line of Figure 1 and whose 8th-grade EOG score was 170. The line at the center is the predicted score generated by the model for these students. A residual is the difference between the actual score and the predicted score. Scores above the line at the center have positive residuals and scores below have negative residuals.

Figure 2
Student Residuals for Average Students with No Program Identifiers



For each test given, the residuals are averaged across all students in the school, and a standardized z-score ("effectiveness index") is generated for each school by subject. A z-score is the number of standard deviations that the school's residual average is from the average (mean) of all the schools with at least 30 students who have test scores and previous scores.

If the z-score is greater than 1, then the students in that course at that school have scored significantly higher (among the top 16%) than other students in the district who have similar previous test scores and program characteristics. Similarly, if the effectiveness index is less than -1, then the students have scores much lower (among the bottom 16%) than other similar students. Values between –1 and +1 are within one standard deviation of the district average, and are considered "typical" or expected (68% of scores should be in this range).

Table 2 is an example of a WCPSS high school effectiveness z-score report. This school was among the top schools in the district for effectiveness in Algebra I, Algebra II, geometry, biology, and physical science, yet the effectiveness scores were among the bottom in civics/economics and U. S. history. The effectiveness scores in English I, chemistry, and physics were about the same as the average scores in the district.

Table 2
Effectiveness Indices for a WCPSS High School
2005-06

End of Course	Z Score
Algebra 1	1.02
Biology	1.82
Civics	-1.00
English I	0.32
US History	-1.44
Algebra 2	1.26
Chemistry	-0.25
Physical Science	1.37
Physics	-0.40

WCPSS principals receive rosters of the student residuals by teacher, course, and section. In these rosters, student residuals above one standard deviation are coded in green, and student residuals below one standard deviation are coded in red. The standard deviation in scale score points of these residual scores is displayed at the bottom of roster, along with the average residual for the section.

Table 3 is a sample roster for a 2005-06 Algebra I class of 17 students. The predictor scores are shown for each student,. The predictors for the Algebra I EOC were the 8th-grade reading and mathematics scores. The roster then displays the EOC scale score and the residual score for each student. These residuals are averaged and an average residual score for the class is provided. The average residual for this class was 1.09. The principal and teacher can then determine how successful students were on the EOC as compared with other students with similar characteristics. Notice that Student 5 and Student 12 have the same scale score on the Algebra I EOC exam, but Student 5 has a negative residual while Student 12 has a positive residual. Student 16 has a lower scale score than Student 7 but a much higher residual. The residual shows a measure of performance as related to previous performance and other educational indicators, and gives a sense of the relative growth for each student. Student 11 has no residual, as previous test scores are missing.

Table 3
Sample High School Algebra I EOC Residual Roster

Name	8th-Grade EOG Reading Scale Score	8th-Grade EOG Math Scale Score	2006 A1 Scale score	2006 A1 Residual
Student 1	260	281	63	-7.52
Student 2	270	285	66	-7.16
Student 3	269	285	70	-6.39
Student 4	272	273	70	-5.17
Student 5	272	279	72	-1.16
Student 6	273	285	76	-0.81
Student 7	277	286	77	-0.23
Student 8	258	275	67	0.41
Student 9	265	267	64	2.04
Student 10	273	283	76	3.00
Student 11	No score	No score	71	No residual
Student 12	264	275	72	4.71
Student 13	270	281	77	5.50
Student 14	270	280	77	6.11
Student 15	269	286	80	6.20
Student 16	262	277	76	8.35
Student 17	273	282	82	9.61

Note: 1. Class Average = 1.09
2. Standard deviation = 5.94
3. EOG is End of Grade exam and A1 is Algebra

Interpretation Example: Student 14 had an 8th-grade reading scale score of 270 and an 8th-grade math scale score of 280. Student 14's 2006 Algebra I scale score was 77 and the student's residual was 6.11. This student scored among the top 16% of students with the same Algebra I score, the same 8th-grade reading and math scores, and the same academic program indicators.

School Performance

Table 4 shows the Algebra I effectiveness indices of 16 WCPSS high schools in 2002-03, 2003-04, and 2004-05 (one of the previous 17 schools was new and did not have data for three prior years). Schools with an effectiveness index above 1 are coded as H for high and below a -1 as L for low. Schools with effectiveness indices between -1 and 1 are coded with an M. The schools were assigned random identification numbers, used throughout this study. The order of schools in no way corresponds to the order in Table 1.

There are three noteworthy points:

- School 6 had high Algebra I effectiveness for 3 years,
- School 3 had low Algebra I effectiveness for 3 years, and
- School 9 is falling in rank.

Table 4
School Level WCPSS Effectiveness Indices

School	2002-03	2003-04	2004-05
1	M-	M-	M-
2	M+	H	H
3	L	L	L
4	M+	M+	M-
5	M-	M-	L
6	H	H	H
7	M-	M+	M+
8	L	L	M-
9	H	M+	M-
10	M+	M-	M-
11	M-	M-	M+
12	H	M+	M+
13	M+	M+	M+
14	M+	M+	M-
15	M-	M-	M-
16	M+	M+	M+

Note:
1. H = effectiveness index >1
2. L = effectiveness index < 1
3. M+ = effectiveness index between 0 and 1
4. M- = effectiveness index between -1 and 0

Teacher Performance

The student residual scores and the effectiveness indices give the district a comparison basis for schools and students. Until recently, residuals had not been averaged or standardized at the teacher level beyond the classroom roster. Prior to 2005-06, teachers were encouraged to study their rosters for trends in student performance, and some principals compared teachers within their school, but no district wide comparisons were made. The study of biology teaching by

Evaluation and Research (E&R Department) staff in 2004-05 was a first attempt at identifying the success of teachers, as indicated by average residuals, and then to identify the specific aspects of the practice of highly effective and relatively less effective WCPSS teachers in order to isolate teachers' classroom practices that may be associated with high student achievement (Haynie, 2006). This study of Algebra I outcomes and practices is the second in a planned series of studies that will target overall systematic improvement as well as individual subject improvement using the residual metric and recognizing that teaching is an essential unit of analysis.

METHOD

The biology study piloted a collaborative study between the WCPSS Curriculum/Instruction Department (C&I) and the E&R Department (E&R) with the goal of identifying best teaching practices. Since both the effectiveness indices and teacher residual averages use residual values that are calculated using student test results, that are known to contain error, combining residuals over three consecutive years of data both reduced the test error and removed inexperienced teachers and teachers who taught biology infrequently. This piloted model was deemed successful. The teachers of the biology study had consistent residual results over the span of four years. For the biology study, the specialist from C&I took the lead in interpreting classroom observation while the specialist from E&R took the lead in data collection and analysis. This basic methodology was used again in this Algebra I study.

CONTEXT AND PARTICIPANTS

This research study took place in WCPSS, a large urban/suburban school district in North Carolina. The WCPSS student population is growing rapidly, with an enrollment of approximately 128,000 in 2005-06. There were 17 high schools in the district, of which 15 were using a block schedule with two semesters per year. One school was on an alternating-day block schedule (a course is 18 weeks in length but taught throughout a full school year). One other school was on a seven-period full-year schedule with 50-minute classes.

In 2005-06, there were 157 high school Algebra I teachers. Sixteen of these teachers were first-year teachers and eight were lateral entry teachers. Forty-one teachers (26% of the 157 teachers) had taught Algebra I in 2002-03, 2003-04, and 2004-05 and were teaching in 2005-06, which made them eligible for this study. For these 41 teachers at 11 schools, the average student residual across all years and classes was calculated. The teachers were ranked on teacher effectiveness from highest to lowest using these averages. The teachers with the nine highest residual averages were labeled T1-T9 and the teachers with the nine lowest averages were labeled B1-B9. The practice of these 18 teachers became the ultimate focus of this study.

Table 4 gives the residual average (in scale score points), the mean of the scale scores, the overall percentage of students who scored proficient, and the percentage of white students and Black/African American students who scored proficient for the 18 teachers studied. The school code used is the same as in Table 3.

Table 5 demonstrates several points:

- the top nine teachers were in seven different schools,
- the bottom nine teachers were in five schools,
- school 14 had both a top and a bottom teacher,
- residual averages ranged from -6.72 to 4.77,
- the achievement gap between White and Black/African American students was much higher for most bottom teachers than top teachers,
- top teacher 1 (T1) and top teacher 2 (T2) taught at the same school, and
- the bottom four teachers (B1- B4) taught at the same school.

Also note that top teacher 3 and bottom teacher 3 have identical percentages of proficient students, but very different residual averages. This shows the value added by the residual analysis, which accounts for how students score in comparison to students with similar previous test performance and educational indicators. The higher residual average of top teacher 3 indicates a higher level of student performance relative to other students. Also, it is of interest that top teacher 2 (T2) mentored top teachers 1 and 3 (T1 and T3).

Table 5
Residual Averages for Top and Bottom Study Teachers

TEACHER	SCHOOL	RES AVG	AVG SS	% PROF	% WH PROF	% BK PROF	ACH Gap
T1	7	4.77	71.6	94	96	89	7
T2	7	4.27	62.4	92	100	100	0
T3	9	3.83	62.4	89	92	90	2
T4	2	3.57	70.4	97	99	92	7
T5	1	3.37	68.5	96	94	96	-2
T6	4	3.26	71.8	97	100	95	5
T7	14	3.17	74.1	100	100	100	0
T8	6	3.01	68.6	100	100	100	0
T9	6	2.95	72.2	100	100	100	0
B9	8	-1.74	61.2	78	88	69	19
B8	14	-2.21	63.2	91	96	85	11
B7	15	-2.22	63.4	87	96	74	22
B6	8	-2.45	61.7	77	90	66	24
B5	5	-3.72	63.0	85	93	75	18
B4	3	-4.80	58.9	78	86	75	11
B3	3	-5.31	55.5	89	92	90	2
B2	3	-5.91	57.5	69	95	57	38
B1	3	-6.72	56.3	55	87	37	50

Note: The overall percent proficient includes American Indian, Asian, Hispanic, and Multiracial students.

Interpretation Example: Teacher T3 teaches at School 9. T3 had a student residual average of 3.83 for all the students of 2002-2005. The average scale score for these students was 62.4.; 89% of these students scored at Level III or Level IV (proficiency); 92% of the White students and 90% of the Black/African American students scored proficient.

INSTRUMENTS, DATA COLLECTION, AND ANALYSIS PROCEDURES

In addition to these student achievement scores, three other types of data were collected for this study. First, a survey was prepared and distributed to the 41 study teachers. The teachers answered 37 written survey questions concerning preparation, planning, use of time, schedules, use of data, and student interaction.

Second, one of the two principal investigators for this study observed 15 of the 18 teachers identified as most effective ("top teachers") or least effective ("bottom teachers"). One of the top teachers was very ill throughout much of the observation year, one bottom teacher never became available, and only three of the four bottom teachers at the same school were observed. The observation instrument was adapted from the one previously used in the biology study (Haynie, 2006). Both of the observers were trained in supervisory observations.

Third, school and teacher focus-group interviews were conducted. There were four school focus groups: Two at the schools with the highest 2004-05 school effectiveness indices, and two at the schools with the lowest 2004-05 school effectiveness indices. There were also teacher focus-group interviews of the top teachers and the bottom teachers. The same questions were explored at all six focus-group interviews.

RESULTS

OVERALL

Student Academic Achievement

Prior performance of students on 8th-grade reading and mathematics EOG state tests was averaged for each of the top and bottom teachers. Table 6 shows the averages and the standard deviations. The overall average 8th-grade mathematics scale score ranged from 264.9 to 278.6 for top teachers and 266.7 to 274.3 for bottom teachers, with the standard deviations ranging from 6.5 to 9.5 for top teachers and from 7.4 to 10.1 for bottom teachers. The overall average was 273.8 for top teachers and 271.5 for bottom teachers, with an overall standard deviation for top teachers of 7.5 and 8.4 for bottom teachers.

Table 6
8th-grade Student EOG Reading and Mathematics Averages
2002-2005

TEACHER	SCHOOL	*n*	Residual Average	8th-grade reading scale score average	8th-grade reading standard deviation	8th-grade math scale score average	8th-grade math standard deviation
T1	7	504	4.77	266.7	6.3	274.3	7.1
T2	7	105	4.27	261.8	6.7	266.9	6.7
T3	9	370	3.83	260.7	6.9	264.9	7.3
T4	2	350	3.57	266.6	6.8	275.3	7.6
T5	1	318	3.37	265.5	7.2	273.0	7.8
T6	4	335	3.26	267.9	6.9	276.9	9.5
T7	14	205	3.17	270.0	4.2	278.6	6.5
T8	6	157	3.01	264.8	7.6	272.9	7.5
T9	6	346	2.95	268.7	6.1	278.4	6.6
B9	8	124	-1.74	266.2	6.6	270.2	10.1
B8	14	360	-2.21	264.6	6.6	271.3	7.7
B7	15	242	-2.22	267.1	6.9	274.3	7.4
B6	8	88	-2.45	265.3	5.5	271.4	8.0
B5	5	290	-3.72	265.5	6.6	273.8	8.5
B4	3	129	-4.80	264.3	5.3	270.9	8.1
B3	3	124	-5.31	261.5	8.8	266.7	9.9
B2	3	150	-5.91	264.8	7.9	270.8	8.7
B1	3	120	-6.72	264.3	7.6	268.9	9.1

Note: *n*'s include only students with residual scores (e.g. 8th-grade EOG scores and an Algebra I EOC score)

Several factors might account, in part, for the results reported in Table 6:

- general academic preparation of students,
- experience level of teachers,
- the teaching assignments of teachers.

We examined each of these.

Academic Preparation of Students

The bottom teachers of this study had not only an overall lower 8th-grade mathematics scale score average but also a higher overall standard deviation. Note though that top teachers 2 and 3 had students with low 8th-grade EOG performances and top teacher 6 had a large standard deviation. Also, there were top teachers who exhibited success with both higher- and lower-achieving groups in terms of their scores in 8th-grade. The residual average controls for the 8th-grade scores and gives a comparison of teachers based on their students' performance regardless of the academic preparation of students.

Teacher Experience and Course Load

Survey results showed that there was no striking difference between the experience levels of the top and bottom teachers. The years of teaching experience for top teachers ranged from 4 to 33 years, with 4 to 17 of those years in Algebra I. The bottom teachers had years of teaching experience that ranged from 4 to 20 years, with 4 to 20 in Algebra I.

The number of Algebra I contacts (students) that top teachers taught in three years ranged from 105 to 504, with 88 to 360 for bottom teachers. The number of mathematics teaching preparations per year ranged from two to four for both top and bottom teachers. Finally, the percentage of Algebra I course sections that were taught by each teacher was calculated. These courses were Algebra I, Algebra I-Part 1, Algebra I-Part 2, Algebra I with Technology-Part 1, Algebra I with Technology-Part 2, and Algebra I Plus. Overall, top teachers were teaching more Algebra I, with seven teachers above 50% of their courses and five of the seven above 75%, compared to three above 50% and only one above 75% for bottom teachers.

Table 7 shows the details of the experience levels. Note that top teacher 2 and bottom teacher 2 illustrate similar experience despite very different residual averages.

Table 7
Professional Factors of Study Teachers

TEACHER	SCHOOL	# of years teaching	# of years teaching Algebra I	# of Algebra I students in residual average	# of preps per year for 2002-03, 2003-04, 2004-05	% of course sections taught from 2002 to 2005 that use Algebra I curriculum
T1	7	11	9	504	2,2,4	94%
T2	7	33	15	105	3,3,4	28%
T3	9	4	4	370	not available	56%
T4	2	28	17	350	3,3,2	89%
T5	1	8	7	318	2,3,3	76%
T6	4	19	16	335	2,3,3	88%
T7	14	16	16	205	3,3,4	56%
T8	6	16	14	157	2,3,2	41%
T9	6	5	5	346	2,3,4	82%
B9	8	17	12	124	4,3,4	32%
B8	14	8	8	360	2,2,2	100%
B7	15	4	4	242	2,4,2	59%
B6	8	4	4	88	2,2,2	50%
B5	5	7	7	290	2,3,2	67%
B4	3	11	11	129	3,3,2	44%
B3	3	10	10	124	3,3,4	38%
B2	3	20	20	150	2,3,3	33%
B1	3	5	5	120	2,3,3	38%

There were also similarities between top and bottom teachers made during the observations. In most observations, students were on task with teacher-led, skill-driven, activities, based on the North Carolina Standard Course of Study (NCSCS).

Marzano's Effective Practices

During the 2004-05 school year, all high school teachers and administrators took part in school-level book studies. The book of choice for all school staff was Marzano, Pickering & Pollock's, *Classroom Instruction that Works* (2001). The book study groups met at various times throughout the year and focused on the effective instructional strategies offered in the text. Because the teachers were familiar with instructional strategies deemed effective by Marzano et al., it followed that this study would analyze implementation of these instructional strategies. Items on the teacher survey addressed the teachers' level of implementation (*daily, often, sometimes, or never*) of each of the strategies identified and described in *Classroom Instruction that Works*. Observations of teachers either confirmed or contested the implementation level of daily use as self-reported on the teacher survey (see Table 8).

Marzano et al. (2001) used meta-analysis to identify instructional strategies and calculate for each an effect size (a measure of the difference in academic performance of groups that used the particular strategy compared to those that did not). The meta-analysis combined many studies of the use of particular instructional strategies.

Nine strategies were found to be most effective:

1. Identifying similarities and differences.
2. Summarizing and note taking.
3. Reinforcing effort and providing recognition.
4. Homework and practice.
5. Nonlinguistic representation.
6. Cooperative learning.
7. Setting objectives and providing feedback.
8. Generating and testing hypotheses.
9. Questions, cues and advanced organizers (Marzano et al., 2001, p. 7).

The above strategies are presented in order of effectiveness on student achievement. Identifying similarities and differences was found to be the most effective strategy. Marzano et al. (2001) suggest that there are four ways for teachers to guide students in identifying similarities and differences:

- comparing,
- classifying,
- creating metaphors, and
- creating analogies (Marzano et al., 2001, p. 13-28).

Three top and two bottom teachers indicated on the surveys that they used similarities and differences daily. Of these five teachers, one top and one bottom teacher were observed using the strategy. In addition, two other top and one bottom teacher were observed using similarities and differences, for a total of 5 out of 15 teachers (one-third), with no observed difference between top and bottom teacher use.

Summarizing and note taking are cited as the second most effective strategy. These activities help students identify and understand the most important ideas in an academic discipline. Both of these activities need to be taught in a way that places purpose in the activity. Students need frameworks for both summarizing and note taking (Marzano et al., 2001, pp. 29-48). The teacher survey separated these into two items. Two top and five bottom teachers reported that they summarize daily. One member of each group was observed summarizing. Five top and five bottom teachers reported using note taking daily. Of these teachers, two top and two bottom teachers were observed using note taking. Both top teachers were providing meaning for the note taking, but only one of bottom teachers was. There was one additional bottom teacher observed summarizing, for a total of 4 out of 15. There was also another bottom teacher observed using meaningful note taking, for 5 out of 15. The percentage of use was about one-third for both groups, but bottom teachers reported more use of both strategies (four of seven) than was observed.

The third strategy is reinforcing effort and providing recognition. Recognition needs to be tied to specific goals so that students learn the value and reward of hard work. Praise can be ineffective if delivered randomly and globally. Effective praise is tied to the attainment of a specified performance of a task difficult for a student (Marzano et al., 2001, pp. 49-59). This strategy was

also divided into two items on the teacher survey. Four top and seven bottom teachers claimed to reinforce effort daily. Of these, three top and two bottom teachers were observed doing so as defined by Marzano. Of the teachers claiming to provide recognition daily, two of three top teachers and three of five bottom teachers were observed doing so. In addition to the teachers reporting daily use, two more top teachers were observed reinforcing effort and four more providing recognition, for a total of five out of eight and six out of eight teachers; compared to a total of two out of seven and five out of seven bottom teachers. Top and bottom teachers provided recognition, but top teachers were observed reinforcing effort more. Although all bottom teachers observed reported reinforcing effort, only two of the seven did so as defined by Marzano where the reinforcement is clearly tied to a specific, difficult goal.

The fourth strategy is homework and practice. This strategy is widely used, but not always in the most effective way. In order for the homework and practice to be meaningful, the purpose must be clearly communicated to students. The results need to be connected to classroom objectives. It can be used to practice a skill or introduce a new concept. Either way, the student should understand the purpose and receive feedback on the homework (Marzano et al., 2001, pp. 60-71). This strategy was observed being used by all top teachers, but one top teacher did not provide meaningful feedback on the assigned homework. Of the bottom teachers, four of nine were observed using it correctly. Three other teachers said they did, but were not observed using any homework. All top teachers were observed using guided practice and all but one used meaningful homework. Three of seven bottom teachers reported using this strategy, but were not using it as defined by Marzano.

Nonlinguistic representations is the fifth strategy (Marzano et al., 2001, pp. 72-83). Since the Algebra I curriculum emphasizes three modes of representation (equation, table, and graph) for most topics, the observers expected to see this strategy used. Yet only one top teacher claimed to use this strategy daily. Four of eight top teachers and two of seven bottom teachers were observed using nonlinguistic representations, for a total of 6 out of 15 (40%).

One bottom teacher claimed to use cooperative learning, but it was not found in observation (Marzano et al., 2001, pp. 84-91). Two top teachers used cooperative learning during the observations, for a total of 2 out of 15.

The seventh strategy is setting objectives and providing feedback (Marzano et al., 2001, pp. 92-102). In a class such as Algebra I where there is a curriculum that will be tested by a state EOC exam, it is easy to assume that everyone knows what the objectives are. Only four top and four bottom teachers marked on their surveys that they provided daily objectives. Of these, only one top teacher was observed doing so. This was the only 1 of 15 teachers observed providing objectives. Marzano states that having goals focuses instruction. The goals need to be flexible so that students can personalize them. They also need to be broad enough to encompass enriching topics.

The feedback that students receive should be referenced to the stated objectives. It needs to be timely, specific, and corrective in nature. Seven of eight top teachers and six of seven bottom teachers said they gave daily feedback. Of these, five top and two bottom teachers were observed doing so. There was one additional top and one additional bottom teacher observed

giving meaningful feedback. Top teachers were observed using meaningful feedback more than bottom teachers (six of eight, compared to three of seven).

Generating and testing hypotheses are often considered part of the scientific process and so should be part of all mathematics classes (Marzano et al., 2001, pp. 103-110). Only two top and one bottom teacher were observed using this method. The one bottom teacher who claimed to do so daily was not observed doing so. Six of eight top and six of seven bottom teachers were observed using cues, questions, and advanced organizers (Marzano et al., 2001, pp. 103-120). Yet questioning was at a much higher level in the classes of top teachers. They probed students' conceptual understanding and the whys behind answers; bottom teachers questioned the steps needed in skills. Top teachers also involved more students during their questioning. Top teachers provided advanced organizers in their warm-up exercises.

Both top and bottom teachers reported more use of Marzano strategies than was observed. Most teachers were providing recognition, as well as asking questions, providing cues, and using advanced organizers. Most top teachers were also reinforcing effort, using guided practice, and providing meaning to homework. Less than one-third of the teachers were using similarities and differences, summarizing, note taking, cooperative learning, providing objectives, or generating and testing hypotheses.

Table 8 summarizes the observations of Marzano strategies.

Table 8
Observation Results of Marzano Strategies

Marzano Strategy	Observed out of 8 top teachers	Observed out of 7 bottom teachers	Observed of top teachers who claimed daily use	Observed of bottom teachers who claimed daily use
1. Identifying Similarities and Differences	3	2	1 out of 3	1 out of 2
2. Summarizing	2	2	1 out of 2	1 out of 5
2. Note Taking	2 purpose	2 purpose 1 no purpose	2 out of 5	2 out of 6
3. Reinforcing Effort	5	2	3 out of 4	2 out of 7
3. Providing Recognition	6	5	2 out of 3	3 out of 5
4. Homework	7 purpose 1 no purpose	4	8 out of 8	3 out of 6
4. Guided Practice	8	4	6 out of 6	4 out of 7
5. Nonlinguistic Representation	4	2	1 out of 1	none claimed daily usage
6. Cooperative Learning	2	0	none claimed daily usage	0 out of 1
7. Providing Objectives	1	0	1 out of 3	0 out of 4
7. Providing Feedback	6	3	5 out of 7	2 out of 6
8. Generating and Testing Hypotheses	2	1	none claimed daily usage	0 out of 1
9. Questions, Cues, and Advanced Organizers	6	6	2 out of 2	5 out of 5

Interpretation Example: Of the 15 teachers observed, 8 out of 8 top teachers and 4 out of 7 bottom teachers were observed using homework. One of the top teachers did not provide a purposeful context for the homework. Of the teachers who had marked their surveys that they used the homework strategy daily, 8 out of 8 top teachers were observed doing so, but only 3 out of 6 bottom teachers were observed doing so.

TOP TEACHER BEHAVIORS

Despite the similarities between top and bottom teachers, some noteworthy differences were found. One of the key differences observed during classroom visits was the use of class time; top teachers spent much more time on average on new material. Table 9 summarizes the observations about time.

Table 9
Classroom Use of Time

Content	TOP	BOT
Old Material	22%	36%
New Material	68%	36%
Wrap-up	10%	28%

One of the principal investigators of this study is the senior administrator for secondary mathematics. Table 10 lists classroom behaviors that she observed in the classrooms of six top teachers, contrasted with the observations of five bottom teachers. Some of these behaviors are Marzano strategies that were noted in Table 8, and others are additional noteworthy findings. This listing summarizes behaviors that were present in most top teacher classes and missing from most bottom teacher classrooms. All six top teachers had created a classroom culture in which students were free to ask questions, contribute, or offer explanations within a structured classroom. Mutual respect was exhibited between teacher and student. Two of the five bottom teachers had a structured management style with mutual respect evident, but none of the bottom five had an open culture in which students freely contributed. All six top teachers used sustained feedback (detailed and complete information that students can understand and use to modify their thinking), but none of the bottom teachers gave this type of feedback. Top teachers took time to tell students what types of questions to expect on tests and assignments, while none of the bottom teachers were observed doing so. Top teachers cautioned students about possible errors commonly made; only one bottom teacher was observed doing so. Top teachers used a variety of activities with frequent transitions (averaging 7 in 90 minutes) and exhibited a sense of humor that added a feeling of fun to the classroom. Two of the five bottom teachers used variety and humor. All six top teachers took time to emphasize the importance of the effort that was needed to complete assignments and to study. Three of the five bottom teachers did this as well.

Five of the six top teachers were observed questioning different students at each step of a problem and using a class warm-up exercise (a task given at the beginning of class) that spiraled to include prerequisite skills necessary for success in the current day's new material. Five of six top teachers were also observed giving purpose to homework (connecting it carefully to the current lesson and using the homework in the lesson explanations). None of the five bottom teachers was observed using these behaviors.

Four of the six top teachers were observed using explanations that were more concept-driven than skill-driven. They emphasized the why behind processes and indicated strategies for approaching the problem instead of memorizing step-by-step algorithms. None of the five bottom teachers was observed explaining concepts and emphasizing processes.

Table 10
Top Teacher Behaviors

BEHAVIOR	TOP	BOTTOM
USED BY 6 OUT OF 6 TEACHERS		
Classroom culture in which students were free to ask questions, contribute, or offer explanations	6 out of 6	0 out of 5
Sustained feedback	6 out of 6	0 out of 5
Told students what to expect on tests and assignments	6 out of 6	0 out of 5
Cautioned students about possible errors	6 out of 6	1 out of 5
Variety of activities-frequent transitions	6 out of 6	2 out of 5
Structured classroom management style with mutual respect	6 out of 6	2 out of 5
Teachers exhibited a sense of humor	6 out of 6	2 out of 5
Emphasized effort in completing assignments and studying	6 out of 6	3 out of 5
USED BY 5 OUT OF 6 TEACHERS		
Questioned different students at each step of problem	5 out of 6	0 out of 5
Class warm-up spiraled to include prerequisite skills for the day's lesson	5 out of 6	0 out of 5
Gave purpose to homework	5 out of 6	0 out of 5
USED BY 4 OUT OF 6 TEACHERS		
Explanations were concept-driven	4 out of 6	0 out of 5
Indicated stratregies for approaching problems rather than memorizing processes	4 out of 6	0 out of 5

There were three other differences of note in the survey responses of top and bottom teachers. First, in response to the instructional mode of delivery, top teachers reported more use of class time in small groups and with technology than did the bottom teachers. Three of the four bottom teachers reported 0% of class time in small group, and the fourth teacher reported 5%. Of the other bottom teacher responses, only three were above 10%, whereas only one of nine top teachers responded 0% and six of nine responses were greater than 10%. All top teachers reported using technology, with eight of nine responses at 10% or more, while one bottom teacher reported no use of technology and only four reported at least 10%.

Second, teachers were asked to rank algebra topics in order of importance in their algebra classes. Both top and bottom teachers chose solving equations as most important, but top teachers ranked linear regression much higher than bottom teachers. Out of 14 topics, eight of nine top teachers ranked it eight or higher, while seven of nine bottom teachers ranked it 10 or lower, with four bottom teachers giving it the lowest possible ranking.

Third, most top teachers (eight of nine) reported planning with other teachers, while six of nine bottom teachers planned alone. In response to how common planning time was used, all the top teachers chose pacing as either first or second in importance. Six of nine top teachers set their own pace, while five of nine bottom teachers used a district-prepared pacing guide.

Both top and bottom teachers stated that their students had weak prerequisite skills. Yet top teachers remediated within material with a spiraled curriculum while bottom teachers remediated before beginning new skills. Eight of nine top teachers stated that their Black/African American

students performed at or above expectations, while five bottom teachers stated that they performed below expectations.

An interesting result was that seven of nine top teachers disagreed with the statement "My students seek understanding of mathematics concepts," while six of nine bottom teachers agreed with the statement. Informal follow-up with the top teachers found that they had a high level of expectation for their students and never felt that they were reaching high enough. These teachers always pushed their students past their students' comfort level with concepts.

There were also differences in the focus-group interview responses of top teachers and bottom teachers, as well as top schools versus bottom schools. The top teachers responded with systemic concerns, sought to learn of others' programs, and shared their ideas for improvement. Bottom teachers responded with personal and management concerns (Fuller, 1969). For example, bottom teachers spent much time discussing the lack of motivation of their students, their unwillingness to do homework, student's lack of prerequisite skills, and their own dislike of an EOC exam that asked questions that the students had not studied. Top teachers discussed their strategies for remediating prerequisites and how their programs taught the NCSCS.

TOP SCHOOL-LEVEL BEHAVIORS

Top school behaviors were identified using the answers from school focus-group interview questions. There were four school-level focus group interviews (two at the schools with the highest 2004-05 school effectiveness indices, and two at the schools with the lowest 2004-05 school effectiveness indices). All teachers who taught Algebra I were included regardless of their number of years of experience.

Experienced Course Leader

The two schools with the highest 2004-05 Algebra I effectiveness scores had a strong experienced course leader. These teachers took lead in seeing that their departments had a school wide plan consistent across classes and aligned to the NCSCS. The school Algebra I leaders encouraged the Algebra I teachers to believe that they could understand the state curriculum and find a way for their students to be successful.

The lack of a strong leader was evident at the bottom schools. The teachers at the two bottom schools spent much of their time complaining about the state curriculum and giving excuses as to why their students could not succeed. The teachers at one of the bottom schools rejected the EOC test and viewed it as an inappropriate measure for their Algebra I courses. One teacher (the department chair) said "The Algebra I EOC should be a skills test." A new teacher asked, "Shouldn't it test what they know?" Another teacher asked, "How can they answer questions worded in ways that they have never seen? They don't ask the questions the way they are taught." There was no teacher leader at this school who explained and supplied information to help both interpret the state curriculum and to say that it is the teacher's job to study and make the state curriculum accessible to students.

A School Wide Plan

Both top schools prepared complete course materials during the summer prior to the first year of implementation of a new revised version of the Algebra I NCSCS. Both schools write their own pacing guides using the district pacing guide as a model. At one top school, the school wide plan is for all Algebra I teachers to use the same daily homework assignments. At the other top school, a commercial curriculum with a book and supplemental materials is used, but the pacing guide is a school-prepared one and many additional lessons are written in order to fully address the NCSCS, especially the technology requirements. Both schools have spiraled curriculum that remediates weak prerequisite skills within the new material. Both schools emphasize problem solving and processes.

Both top schools used materials thoughtfully. The school that had common homework assignments only used a textbook as a reference. The teachers said that the NCSCS was the curriculum, not the textbook. The teachers at this school were also emphatic about using teacher-made tests, not tests supplied with the book. The teachers at the other school felt that many of the prepared tests supplied with their book were appropriate to use, but they have selected the text carefully. Both schools withheld calculator use at the beginning of their courses; they wanted to build confidence in basic skills first, and introduce the calculator as a tool that supplements, but does not replace, human thought.

Both top schools had support structures for teachers, with special consideration of new teachers; they handed teachers the prepared materials for the entire course. They also had experienced teachers meet with new teachers to listen to their concerns, explain the materials, and help with test writing.

All the teachers of these top schools expressed a pride in their department and felt part of a successful team. One of the bottom schools had no team planning, while the other school's teachers spent much of their planning time expressing negative opinions toward any suggestions for ways to improve (there were many "yes, but" comments made). Teachers at this school said that they planned together, but there was no concrete evidence of a school wide plan. When asked by their principal to show weekly lesson plans, they seemed overwhelmed at how to fulfill this request.

CONCLUSIONS

The main goals of this research study were to collect system-specific data to help teachers and district leadership understand current Algebra I practices, identify and share best instructional practices in Algebra I, continue to build a series of studies that identify the role of teachers, and other system staff/departments in the school improvement process, and identify the practices of effective improvement.

It can be concluded that in 2005-06, eight WCPSS high schools (47%) had more than 90% of their students score proficient (at Level III or IV) in Algebra I. Fifteen high schools (88%) scored above the state proficiency of 76.1%, and 12 high schools (71%) made the state high growth measure. These percentages all seemed high. Yet the schools had from 7% to 31% of

their Algebra I students scoring below proficiency. The highest scale-score average was 68.5, well below the highest scale score possible of 96. Few WCPSS high school students scored in the top half of Level IV. There was much room for improvement at all schools.

The WCPSS effectiveness indices for schools and the average residual scores for teacher identify schools that and teachers who can be used to document best instructional practices in Algebra I. There are highly effective teachers in schools that are ineffective overall. There are schools that are very effective overall and have a clear school wide plan for success. There are teachers motivating low-performing students to success in Algebra I. Yet in this study, there was one school that had four teachers with low effectiveness and that overall was less effective than most other WCPSS schools. It can be concluded that there are other WCPSS teachers and schools whose students are also producing less than their best work.

Behaviors of Top Teachers

Although both top and bottom teachers agreed that their students had weak prerequisite skills, the attitude toward these students and the approach for remediating was quite different. The top teachers and schools believed that they could remediate within a spiraled curriculum of new material and that their students could be successful learning new material while reviewing old material. One teacher at a top school said, "Our students are proud of how they do."

Effective teachers in this study also had a plan before the school year began. If the plan was a school wide one, then the entire school was more likely to be effective and new teachers were supported to success quickly. The plan was aligned to the NCSCS,with textbooks as one among many possible resources. Teachers planned the objective for the day by a concept or goal description and not by a chapter number or name from a textbook. The most effective Algebra I teachers spent most of their planning time together discussing pacing. The course plan was regularly updated to reflect the pacing needs of students and curriculum.

When asked about important topics in Algebra I, highly effective teachers agreed that the teaching of problem solving, how to approach exercises in general, and concepts behind questions were of most importance. None of these is specifically named in the NCSCS, yet top teachers saw these as key to success in mastering the curriculum and in being prepared for future mathematics courses. Bottom teachers did not think that they had time to work on problem solving. They were too busy insisting that students memorize algorithms and work on skills.

The thoughtful use of time and materials was observed in classrooms of top teachers. Among top teachers, there was an urgency to teach from bell to bell. Top teachers used opening questions and exercises to quickly review past skills and serve as advanced organizers for new material. Top teachers watched time carefully, using the bulk of the period on new material, yet leaving the final five to nine minutes for a wrap-up. Bottom teachers were observed using the majority of their time on old material and wrap-up. One bottom teacher was observed allowing students 20 minutes at the beginning to check homework answers with a key on the overhead projector, and then, after an interesting 50 minute lesson, the class spent the last 20 minutes copying the next homework assignment. Despite the interesting lesson there was much off-task behavior at the beginning and end of class.

It can be concluded that both top and bottom teachers reported more use of Marzano strategies than was observed. Most teachers were providing feedback, as well as asking questions, providing cues, and using advanced organizers. Questioning was at a much higher level in the classes of top teachers. They probed their students' conceptual understanding and the whys behind answers; bottom teachers questioned the steps needed in skills. Top teachers also involved more students during their questioning. Top teachers provided advanced organizers in their warm-up exercises.

The use of homework was observed in most classes, but only the top teachers were observed taking the time to give purpose to the homework. Top teachers explained why they chose a homework assignment and how it would reinforce or introduce a concept. They used homework questions within a lesson to review or explain concepts. Bottom teachers checked to see whether the assignment was done but did not use homework meaningfully during the day's lesson.

Only one teacher was observed providing the day's objective, yet eight said that they did so daily. There seemed to be an implied objective that could be observed from the activities and exercises of the day, but was not clearly stated in words of the NCSCS. Since there was no clearly stated objective, the wrap-ups at the end of class lacked a feeling of closure that would help students make sense of the time that they had spent in class and on their homework.

Only 3 of 15 teachers generated and tested hypotheses. Only 5 of 15 teachers used similarities and differences. Only 4 of 15 summarized, and only four of eight top and two of seven bottom teachers used nonlinguistic representations. Marzano (2001) found all of these instructional strategies to be highly effective in promoting student learning, and these techniques are promoted by the National Council of Teachers of Mathematics. All four of these strategies can be used daily in any mathematics classroom. There was room for improvement in all the teachers in the study.

Summary

The following conclusions were made of the most effective teachers:

- They actively participated in developing and using an instructional plan aligned to the standard course of study.
- They planned with other teachers.
- They were concerned about pacing.
- They used a spiraled curriculum that introduced new material while remediating prerequisites.
- They created a structured but positive classroom culture.
- They emphasized problem solving.
- They had a positive attitude toward student performance.
- They used materials and class time thoughtfully.

The following conclusions were made about the most effective schools:

- They had a strong experienced course leader.
- They had a school wide plan consistent across classes aligned to the standard course of study with six components:
  - ► materials ready for the entire year,
  - ► remediation within new material,
  - ► emphasis on problem solving and processes,
  - ► spiraled curriculum,
  - ► support structures for teachers with special consideration of new teachers, and
  - ► materials used thoughtfully.

DISCUSSION AND IMPLICATIONS

The evidence is clear from both this study and the previous biology study that there are teacher and school models of effectiveness that can serve as exemplars for other teachers and schools within our school system (Haynie, 2006). Most schools have pockets of excellence and other areas in need of improvement. This study identified some areas where all teachers are falling short of excellence.

The overall state of Algebra I in WCPSS is healthy and performing well, yet there is much room for improvement. It is clear from this study that the attitude, focus, and commitment of the top teachers produced high performance in their students and that all students can be successful in Algebra I given the right environment.

The bottom teachers felt that they could not go into new material without first reteaching the prerequisite skills. They viewed Algebra I as a fixed linear progression. This attitude often led to a negative classroom atmosphere in which students felt inadequate and defeated. The students were bored with the old material and had accepted that they could not do any better. Some bottom teachers also voiced negative attitudes toward their students. These bottom teachers characterized their students as noisy, immature, dependent, unable to think on their own, or having poor study skills. Top teachers created a positive classroom culture with a positive attitude toward student ability to perform well. Interestingly, these top teachers also used humor.

Accepting, studying, and facilitating the NCSCS is crucial to student success. A bottom teacher was observed providing a rich, comfortable mathematics environment where students were actively engaged in their learning, but when introducing a new topic she spent two-thirds of a class period on Algebra II material that would not be tested in Algebra I. She said to the students, ″When you see this on your EOC exam, I want you to ------″. She was unaware of the Algebra I curriculum requirements and used class time unwisely. Enriching the curriculum beyond the minimum requirements is an acceptable practice and encouraged with advanced students, but the basic curriculum must be taught first and teachers need to know when they are enriching it. Top teachers had a plan that aligned to the curriculum.

Content knowledge is also very important. The top teachers were able to use high-level questioning because of their depth of understanding of algebra. They responded to student

questions with greater clarity than bottom teachers. Developing depth of content knowledge takes a commitment to continual study and reflection.

Teaching is a complex profession. The top teachers of this study had more of the necessary components present in their classrooms. Most bottom teachers had parts, but not the whole. Some had great content knowledge and instructional presentation but mismanaged their time or did not know the curriculum well. Others managed time well, but were off curriculum or had weak content knowledge. Some bottom teachers did not believe that their students could learn.

The following recommendations for improvement are made to all Algebra I teachers:

- Study the standard course of study and EOC testing program.
- Study goal summaries.
- Study residual rosters.
- Plan with other teachers.
- Understand and implement Marzano strategies.
- Use and/or develop a school plan for Algebra 1.
- Study mathematics to increase depth of content knowledge.
- Reflect on performance data and instructional practice.

This study found, as did the biology study, that there is a school effect in successful performance of students in their courses. The school effect is department-driven. Most schools have some departments working together and performing better than other departments in the school. Although a teacher can be successful in a weak department, some schools have plans that support the success of all teachers including those new to the profession.

One of the greatest concerns voiced by many of the teachers of this study was the high turnover of teachers in Algebra I and the high number of new teachers assigned to teach Algebra I. Only 26% of the 157 Algebra I teachers in 2005-06 had taught Algebra I consecutively the three previous years. Experienced teachers often request to teach higher-level courses, while new teachers request Algebra I, thinking that it is the most familiar material. Higher-level courses are used as rewards for longevity. Since Algebra I is a required course for all students and the Algebra I EOC must be passed, it is important to have a school wide assignment plan that ensures students have good teachers. A new teacher can be good if supported by experienced teachers and if there is a curriculum-aligned school pacing guide.

It was also observed that the bottom teachers had students with an overall lower 8th-grade mathematics scale score average, and an overall higher standard deviation of these eight grade scores. This would indicate that these teachers have, on the whole, a more challenging student assignment than the top teachers. Since observations showed the top teachers to be using better teaching practices and to be better overall teachers, it could be concluded that often top teachers were being rewarded with better teaching assignments than the bottom teachers.

Top schools have found a way to schedule mathematics teachers that ensures stability of leadership and experience in Algebra I, while also giving teachers an opportunity to grow in

higher-level courses. Schools must collaborate with teachers to convince them of the importance of Algebra I and together develop an assignment plan of success.

The following recommendations are made to school-based leadership:

- Develop a school plan that aligns to the standard course of study, emphasizes problem solving, and supports new teachers.
- Support meaningful common planning for teachers.
- Share results data with teachers including effectiveness rosters and indices.
- Develop a scheduling plan that maintains stability in Algebra I while adjusting to performance results over time and giving teachers opportunities to grow.
- Support a school culture that promotes open discourse at all levels.

This study (and the earlier biology study) also identified areas where central district leadership can help facilitate school improvement. Since central leadership has access to all schools and time dedicated to supporting schools, their main function can be sharing and explaining the best practices observed.

The following recommendations are made to district leadership;

- Make observations of most effective schools and teachers that can be shared district wide.
- Provide workshops on implementing Marzano strategies.
- Support school wide improvement efforts based on top school models.
- Support teacher improvement efforts.
- Provide data to teachers and schools on their effectiveness.

This Algebra I study added valuable data to that collected in the biology study. Teacher effectiveness studies will continue in WCPSS and overall conclusions will crystallize in time.

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