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EFFECTIVE BIOLOGY TEACHING: A VALUE-ADDED INSTRUCTIONAL IMPROVEMENT ANALYSIS MODEL

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ABSTRACT

This research study developed a value-added instructional improvement analysis model. North Carolina state testing results were used in regression and residual analyses of student achievement. This analysis allowed for identification of the "most effective" and "least effective" biology teachers in Wake County Public Schools (WCPSS). The study found that the "most effective" biology teachers were focused on the delivery of biology instruction; resisted distractions from their classroom efforts; maximized student use of class time; studied and planned with other teachers using the North Carolina Biology Standard Course of Study; focused all student time on the Standard Course of Study goals; carefully planned teacher controlled student activities; and used data to guide their instructional practice.

INTRODUCTION

Many variables contribute to student success, but most experts now agree that the teacher is a key factor. Several studies of student gains from one year to another on standardized tests find 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 recognized by the Elementary and Secondary Education Act of 1965 (ESEA), as amended by the No Child Left Behind Act of 2001 (NCLB). Under NCLB, every state must develop and implement a plan that ensures that all students will be taught by a "highly qualified teacher" (HQT; 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 is committed to the goal of every child being taught by an HQT by the end of 2005-06, and then outlined the actions that will be taken to support states in reaching this goal (Spellings, 2005).

The importance of teachers is also recognized in the National Science Education Standards. Chapter four is devoted to the standards for the professional development of teachers. Professional Development Standard C gives a list of musts for professional development activities. Among the list are "Provide opportunities for teachers to receive feedback about their teaching and to understand, analyze, and apply that feedback to improve their practice" (National Research Council, 1996).

In North Carolina, all public high school teachers are required to follow a Standard Course of Study that specifies the goals and objectives of each course. For 10 of these courses, students are also required to take an End-of-Course (EOC) examination based on these goals and objectives. This requirement has been in place for several years. Thus, a database has been created that allows calculation of average scores for classes taught by any teacher over time. As part of a statewide school improvement project that predates the NCLB, the state of North Carolina provides monetary incentives to teachers in schools in which students attain specified levels of academic growth as demonstrated primarily on EOC tests.

This research project used the state database in district regression and residual analyses of student achievement. This analysis allowed for identification of the "most effective" biology teachers and "least effective" biology teachers in WCPSS. Observation of classroom practice of "most effective" teachers produced meaningful feedback for all teachers to use in improving their classroom practice.

PURPOSE OF THE RESEARCH

The main goal of this research study was to develop a value-added instructional improvement analysis model. Unlike most current valued-added models, teacher performance evaluation was not a goal of this study (Braun, 2005; Olson, 2005; Olson, 2004; Sanders, 1998; Tucker & Stronge, 2005). The value-added model incorporated collaboration between the WCPSS' Evaluation and Research Department and the Curriculum and Instruction Department. Classroom instructional practices of "most effective" and "least effective" biology teachers, identified by the Evaluation and Research Department on the basis of aggregated student residuals, were observed, contrasted, and shared with school principals and teachers to facilitate discussion and improved practice. The observations were led by the staff of the Curriculum and Instruction Department.

BACKGROUND

WHY START WITH BIOLOGY?

Students must take a variety of courses to graduate from high school in North Carolina, but not all of these courses have an associated EOC exam. Of the required courses for which an EOC exam is used (Algebra I, Biology, Civics and Economics, English I, and U.S. History), Biology had the largest achievement gap between White and Black students. In 2004-05, 87.4% of WCPSS White students scored at proficiency but only 47.2% of WCPSS Black students scored at proficiency.

Biology is one of the 10 high school courses tested in the North Carolina ABC accountability program, the initiative designed to improve school outcomes. The program rewards schools and educators when students' academic achievement meets or exceeds growth standards established for each student group or class. Performance on EOC exams, percent of students graduating prepared for college, and reduction of students dropping out are all considered in calculating ABCs results (North Carolina Department of Public Instruction [NCDPI], 2005**)**. In WCPSS, Biology had the second largest number of enrolled students of the eight EOC courses tested in 2004-05 (Civics and Economics and U.S. History were not tested from 2003 to 2005). The district achieved expected, but not high, growth in Biology. Disaggregation of performance by race showed that Black students did not make expected growth, but the high growth of White students was sufficient to overcome this deficit. Four WCPSS high schools did not make expected growth in Biology and 11 other schools made expected, but not high, growth. The fact that the district's board of education has embraced its own performance goal—Goal 2008— which calls for high growth by all student subgroups, intensifies the pressure on high schools to improve outcomes in biology for all students.

DEFINING EFFECTIVENESS

In the State

In North Carolina, EOC exams are administered in 10 high school subjects including biology. 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's 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 proficiency in the course content, and are considered proficient (NCDPI, 2004).

Teachers receive rosters of students scale scores, level scores, and a 100-point scale score. An average scale score is also reported at the bottom of each roster. The percentages of students passing each EOC and all the EOCs in a school are reported publicly. Teachers judge their own success using these percentages. The scores can also be disaggregated into many subgroups (i.e. students with disabilities, free or reduced-price lunch students, academically gifted 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 state's accountability program. However, because the program has two standards of achievement (the absolute percentage of tests at or above grade level and the attainment of "expected" growth), the aggregated scores of students tested must also meet or exceed the school's growth prediction across all EOC subjects. The predicted growth is calculated on the basis of the history of previous tests taken by students. For the biology EOC, for example, the test scores used in the prediction model are 8th-grade reading and mathematics scores. If the school makes expected growth, all teachers receive a monetary bonus, regardless of the percentage of students testing at or above grade level. Note that the growth targets are based on the growth of students in the school; thus setting what teachers deem a "fairer" measure of success than student proficiency alone. Teachers and schools with 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.

Across the state of North Carolina, 63.6% of students on average achieved a Level III or IV score on the biology EOC in 2004-05. In WCPSS, 74.2% of students passed the biology EOC. These scores are still considered far from successful, particularly when only 46.7% of Black students earned proficient scores. Additional measures are needed to identify teachers who are producing the most growth in students. The state does not report any measure of growth by student, as the accountability system is based on school averages, not individual student scores.

In the district

The state provides test analysis software to every district in the state that can be used to run school-level results and some simple disaggregations. The state also posts disaggregated results on a website. These analyses, however, are limited to average scale scores, percentages of students tested who attain proficiency, expected growth, and high growth values by subject. Although these statistics provide some 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. If all schools in the district are attaining either high growth or below expected growth in a subject area, there is a need to know which schools are producing the most growth in order to share the best practices of the district and give a vision of potential performance to the lowest-performing schools.

Since school year 1999-2000, this school district has computed residual scores for all state test scores of students who have the necessary pretests. These residuals give a measure of how students performed compared to other similar students (i.e. students with the same pretest scores and program identifiers). These residual scores are produced using regression analysis with the current year's test scores as the dependent variable and the state-designated pretest scores as independent variables. Indicator variables control for special program status (level of service, e.g. self-contained), free or reduced-price lunch status, academic gifted status, and percentage of free or reduced-price lunch students in the school. The residual score for a student is the difference between the student's actual score and the predicted model score.

In each subject, the student residuals are averaged across all students in the school, and a standardized z-score ("effectiveness index") is found for each school by subject. If the z-score is greater than 1, then the school knows that its students have made significantly more growth than the other students in the district who have like pretests and program codes. Similarly, if the effectiveness index is less than -1, then the students have made much less growth than other students like them. Values between –1 and +1 are within one standard deviation of the district average.

Principals receive rosters of student residuals by teacher, course, and section. The standard deviation of these residual scores is displayed at the bottom of the roster. Student residuals above one standard deviation are coded in green, and student residuals below one standard deviation are coded in red. An average residual for the class is provided also at the bottom of the roster.

Table 1 is a sample roster for a 2004-05 biology class of 17 students. For each student, the predictor scores are shown. As mentioned above, the predictors for the biology EOC are 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 of this class was 3.71. 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 3 and Student 6 have the same scale score on the biology EOC exam, but Student 3 has a negative residual while Student 6 has a positive residual. Student 7 has a lower scale score but a higher residual than either Student 3 or 6. 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.

TABLE 1
Sample High School EOC Residual Roster

Name	8th Grade EOG Reading Scale Score	8th Grade EOG Math Scale Score	2005 BI Scale score	2005 BI Residual
Student 1	262	268	56	-0.53
Student 2	263	275	70	11.21
Student 3	270	290	63	-3.90
Student 4	264	276	68	8.46
Student 5	269	279	68	6.20
Student 6	271	276	63	2.16
Student 7	268	264	62	5.36
Student 8	256	274	51	-5.31
Student 9	278	278	66	1.80
Student 10	164	269	61	3.72
Student 11	No score	No score	62	No residual
Student 12	165	271	68	9.64
Student 13	259	270	62	4.35
Student 14	No score	No score	55	No residual
Student 15	270	277	66	4.42
Student 16	No score	No score	55	No residual
Student 17	159	255	54	4.36

EOG End of Grade Exam
BI Biology

At the Teacher Level

The student residual scores and the effectiveness indices give the district a comparison basis for schools and students. Yet, except for the classroom residual averages, the student residuals had not been averaged or standardized at the teacher level. In the past, teachers were encouraged to study their rosters for trends in student performance and some principals had compared teachers within their school, but no district-wide comparisons had been made. This study 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 teachers in order to isolate teachers' classroom practices that may be associated with high student achievement. method.

METHOD

CONTEXT AND PARTICIPANTS

This research study took place in WCPSS, a large urban/suburban school district in North Carolina. The student population is growing rapidly, with an enrollment of approximately 120,000 in 2005-06. There were 16 high schools in the study; 14 were using a block schedule with two semesters per year (i.e. a biology course is 18 weeks long, 90 minutes per day). 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. Fifteen schools offered both honors and academic (average) biology. One school taught biology in non-leveled heterogeneous classes. Most biology students in these schools were in ninth or tenth grade.

The biology teachers at all 16 high schools participated in the study to some extent. Site visits were made to all schools and biology team interviews were held. Forty-three of these teachers were the primary focus of the analysis. These teachers had taught at least one section of biology in four consecutive school years, beginning in 2001-02. Thus, a large amount of student achievement data for each of the teachers was available. These teachers had between 4 and 34 years of experience teaching biology. Every high school in the district had at least one teacher in the sample, and one high school had five teachers.

INSTRUMENTS, DATA COLLECTION, AND ANALYSIS PROCEDURES

Biology student residual scores were averaged by teacher for all students taught by the 43 teachers of interest. The averages were rank-ordered from highest to lowest, yielding a roster of “most effective” to “least effective” biology teachers. In addition to these student achievement scores, three other types of data were collected. First, a survey was prepared and distributed to the 43 study teachers. The teachers answered 35 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 also visited each of the high schools in the district making observations and conducting group interviews with the biology teachers. The observation instrument and an interview protocol were adapted from the National Science Foundation Coastal Rural Systemic Initiative (CRSI). Both of the observers were trained in supervisory observations.

The 43 teachers who had three consecutive years of student test data in biology from 2002 to 2004 were randomly assigned an identification number and the 16 high schools were also assigned a random identification number. The 10 teachers with the highest average residual values were designated as “top” teachers and the 10 teachers with the lowest average residual values were designated as “bottom” teachers. Although 43 teachers were surveyed, the survey analysis focused on these top and bottom teachers.

Classroom observations were made of these 20 teachers during the school visits. Results of the group interviews were reported, as promised, to both the teachers and school administration. These results were considered to be beyond the targeted point of the study and a way to shield the identity of the top and bottom teachers. A list of the rankings of the teachers was not released.

RESULTS

RESIDUALS

The identification of teachers with highest and lowest average student residuals was a stable measure across the three years and into the fourth observation year. After testing in May 2005, the top 10 teachers of the previous three years again had high average residuals and the bottom 10 teachers had low average residuals when compared to all district biology teachers. The teacher with the highest average residual and the teacher with the lowest average residual were the same two teachers all four years when compared to all teachers teaching biology (not just the teachers who taught it for three consecutive years, see Table 2). The top teacher had taught in two schools during the span of study years. The top 10 teachers were in seven schools, the bottom 10 teachers were in seven schools, and two schools had both top and bottom teachers.

TABLE 2
Average Residual Scores for Top and Bottom Teachers

Teacher	Residual Average 2002-04	Ranking in Study of 43 teachers	Residual Average 2005	Ranking out of 80 in 2005
33	4.905	1	4.09	1
17	4.033	2	3.74	3
25	3.437	3	1.540	14
10	3.178	4	1.882	9
34	2.800	5	1.601	12
18	2.557	6	2.290	6
15	2.299	7	1.507	16
43	2.277	8	0.837	23
39	1.862	9	0.791	24
42	1.627	10	0.549	28
29	-0.819	34	-2.008	68
40	-1.008	35	N/A*	N/A*
36	-1.474	36	-1.186	60
21	-1.565	37	-1.622	66
2	-1.845	38	-2.916	78
30	-2.058	39	N/A*	N/A*
24	-2.309	40	-0.785	55
31	-2.433	41	-2.894	77
4	-2.784	42	-2.332	74
20	-3.051	43	-3.221	80

*these two teachers did not teach biology in 2004-05

As expected, high student scale scores did not always equate to high student residuals. There were teachers in the top, bottom, and middle of average student residuals who had high or low student performance. For example, a teacher whose students were 99% proficient was ranked 20th in effectiveness based on residuals. Disaggregating the average residuals by student ethnicity also showed some variance in rankings. One top 10 teacher was ranked 20th for Black students (see Table 3).

TABLE 3
Comparison of Teacher Residual Rankings to Percentage of Students Scoring at Proficiency

Teacher	Overall Residual Ranking	White Residual Ranking	Black Residual Ranking	Overall % at Level III or IV	White % at Level III or IV	Black % at Level III or IV
17	2	2	1	94	97	84
18	6	5	20	87	92	57
39	9	10	8	87	95	64
42	10	9	10	75	91	60
12	**20**	**20**	**18**	**99**	**100**	**95**
2	38	38	36	64	87	49
31	39	43	37	81	90	40
21	41	30	41	71	90	48
20	43	42	43	54	86	28

COMPARING TOP WITH BOTTOM

Comparing the survey data from top teachers and bottom teachers was a difficult and multifaceted task. There was much variance between teachers on all measures. Generalizations were found, yet there was an exception to every generalization.

Experience and Assigned Instructional Time

The years of experience teaching biology ranged from 6 to 32 for top teachers and from 4 to 30 for bottom teachers. The median was 18.5 years for the top teachers and 9.0 years for the bottom teachers. Top teachers generally had more experience than bottom teachers; yet there was a first-year teacher among the teachers with top residual averages in May 2005 and a bottom teacher with 30 years of experience.

From 2001 to 2004, the top teachers reported a mean of 1.6 different courses taught compared, to a mean of 2.0 courses for bottom teachers. Five top teachers (50%) taught only biology compared to 2 bottom teachers (20%). Top teachers averaged 83.4% of their instructional time in biology, compared to an average of 64.7% for bottom teachers. Top teachers taught 0 to 16 honors sections in three years, with three teachers teaching all honors, one teaching all academic, and seven teaching more honors than academic. Bottom teachers taught 0 to 7 honors sections, with one teacher teaching only honors, three teaching only academic, and one teaching more honors than academic (see Tables 4 and 5).

Table 4
Experience and Instructional Time of Top Teachers

Teacher	Overall Residual Ranking	# of Years Teaching Biology	# of Different Courses Taught	% of Instructional Time in Biology	# of Sections Honors Biology	# of Sections Academic Biology
33	1	32	2	74	11	0
17	2	8	2	66	7	5
25	3	29	2	70	12	0
10	4	28	1	100	16	0
34	5	20	1	100	8	4
18	6	10	2	87	5	10
15	7	7	1	100	11	5
43	8	10	3	50	6	5
39	9	6	1	87	4	10
42	10	17	1	100	0	9

Table 5
Experience and Instructional Time of Bottom Teachers

Teacher	Overall Residual Ranking	# of Years Teaching Biology	# of Different Courses Taught	% of Instructional Time in Biology	# of Sections Honors Biology	# of Sections Academic Biology
29	34	6	2	42	0	7
40	35	10	2	44	2	4
36	36	11	3	50	0	8
21	37	6	2	83	7	7
2	38	8	3	75	6	6
30	39	25	2	51	0	8
24	40	15	2	81	1	12
31	41	30	2	21	4	0
4	42	4	1	100	4	9
20	43	4	1	100	6	12

Use of Instructional Time

Analysis of the teacher questionnaires revealed much about classroom practice. Top teachers focused most of their class time in lecture and lab. Of the top teachers, 80% spent 50% or more class time in these two activities, compared to 40% of bottom teachers. There was little difference between top and bottom teachers on using labs (top teachers ranged from 10% to 45% of instructional time with a median of 22.5%, compared to a range of 10% to 50% and a median of 20% for bottom teachers). There was a noticeable difference in the use of lecture (top teachers' use ranged from 20% to 60% with a median of 32.5% (see Table 6), while bottom teachers ranged from 10% to 50% with a median of 20% (see Table 7)).

Table 6
Use of Instructional Time of Top Teachers

Teacher	Overall Residual Ranking	Lecture	Labs	Whole Group Discussion	Demos	Projects	Small Group Discussion	Partner Work	Testing	Other
33	1	50%	15%	0%	5%	0%	15%	0%	8%	7%
17	2	30%	25%	3%	7%	3%	6%	15%	11%	0%
25	3	60%	20%	5%	5%	0%	0%	0%	10%	0%
10	4	25%	35%	5%	1%	3%	15%	10%	7%	0%
34	5	35%	15%	10%	2%	1%	17%	18%	2%	0%
18	6	20%	20%	5%	0%	0%	10%	20%	15%	0%
15	7	20%	20%	5%	5%	5%	5%	15%	15%	10%
43	8	20%	45%	10%	5%	5%	5%	5%	5%	0%
39	9	60%	10%	0%	5%	5%	0%	10%	10%	0%
42	10	50%	10%	0%	0%	0%	10%	10%	10%	10%

Table 7
Use of Instructional Time of Bottom Teachers

Teacher	Overall Residual Ranking	Lecture	Labs	Whole Group Discussion	Demos	Projects	Small Group Discussion	Partner Work	Testing	Other
29	34	20%	25%	5%	5%	5%	10%	20%	10%	0%
40	35	30%	20%	0%	0%	0%	20%	20%	10%	0%
36	36	10%	10%	5%	5%	30%	15%	15%	10%	0%
21	37	10%	50%	0%	1%	5%	5%	9%	10%	10%
2	38	10%	10%	20%	5%	30%	10%	10%	5%	0%
30	39	10%	20%	10%	0%	5%	30%	10%	5%	10%
24	40	15%	25%	9%	10%	5%	30%	10%	5%	0%
31	41	40%	25%	5%	2%	10%	3%	5%	10%	0%
4	42	50%	10%	10%	5%	5%	10%	5%	5%	0%
20	43	20%	20%	5%	5%	10%	20%	10%	10%	0%

There was also an apparent difference in the use of class time for projects, small group discussion, and partner work. The top teachers' use ranged from 0% to 36% with a median of 22%. The bottom teachers' reported time ranged from 18% to 60% with a median of 40%. The top teachers also reported more testing. Their percentage of time devoted to testing ranged from 2% to 15% with a median of 10%, compared to a range of 5% to 10% and a median of 7.5% for bottom teachers (four bottom teachers reported 5% and six reported 10%) (see Tables 6 and 7).

While the term "lecture" may cover a variety of activities, it seems clear that the top teachers exercised more control over time use and student attention. These teachers tended to spend more time on teacher-controlled activities but relatively less class time on projects, partner work, and small-group discussion.

Planning

Seven of the top teachers said that they planned for instruction with one or more teachers, but six bottom teachers reported always planning alone. The district provides a pacing guide for biology instruction with suggested classroom tasks. Of the top teachers, only one teacher (who had participated in writing the pacing guide) reported using most of the suggested tasks. Nine top teachers used some or none. Of the bottom teachers, five marked most or many, four some, and only one none. Top teachers reported planning most of their activities themselves, while more bottom teachers used resources already prepared.

Use of Data

All 10 top teachers reported that they used data in the planning of instruction, while three bottom teachers stated they had no time for data (including one department chair of a school with a low effectiveness index). Nine of the 10 top teachers reported using data that they collected, and nine used data from the school and district administration. Two top teachers were at a school that had developed common classroom assessments that were used to report proficiency on biology goals to students and to provide goal-based regular structured remediation to students.

The school with the highest district effectiveness index (two of the top teachers taught in this school) used goal summary reports provided by the state testing program from previous years to plan the pacing and delivery of instruction. A "year at a glance" document was written. The instruction was goal-driven, not book-driven. This was also the school where a first-year teacher had a top ranked residual average in 2005.

Barriers to Effectiveness

Top teachers were generally of one mind when asked about the main barrier to their effectiveness with students. Nine gave answers related to time. Six cited lack of class time with students (too much material in the curriculum) and two cited lack of time to plan and meet with students (too many other duties). One top teacher said that there was too much in the curriculum (causing a time issue). One teacher thought students did not study. This answer was the only response not related directly to time with students.

The bottom teachers did not show a similar consensus of answers. There were seven different answers. Three cited 'Time" with no explanation, two said "too many other tasks, too much paper work, and surveys", two said "too much in curriculum", one cited parental home structure, one said "students can't read, student motivation, and class size", one said "lack of colleague support", and one gave no answer.

Classroom Observations

WCPSS' science curriculum specialist, one of the two researchers conducting this study, conducted observations in the classes of most and least effective teachers. His overall observations of most effective teachers were that they:

- participated in group planning.
- worked on and used a common pacing guide.
- held EOC review sessions by selected content.
- made data driven decisions about which goals and objectives to stress.
- conducted frequent assessments.
- communicated to students their progress on state standards.
- were in schools that had strong departmental leadership.
- designed a "year at a glance" document.
- presented themselves as professionals (they were well dressed).

CONCLUSIONS

The main goal of this research study was to develop a value-added instructional improvement analysis model that was a collaborative effort of the WCPSS Evaluation and Research Department and the Curriculum and Instruction Department. This goal was accomplished. The year-to-year consistency of teacher residual rankings in the district showed that teachers who produce the most growth in students on EOC tests can be identified. It should be remembered that this is a high performing district and that even teachers on the lower end of the residual rankings may be more effective than other teachers in the state, but with regard to local standards of performance, they are producing less growth in their biology students. The surveys and observations of these teachers provided information about some of the classroom practices that may be contributing to growth. The results of this study were shared with principals and teachers. Understanding of and confidence in residual analysis has been heightened throughout the district. Collaboration between the two departments involved continues, and an Algebra I project is in progress.

Since the residual averages were shown to be stable, the average residuals for all EOC and End-of-Grade (EOG) subjects were analyzed in order to provide principals and teachers with the values above which, and below which 25% of all teacher residual averages fall. For example, in Biology, if a teacher's residual average is above 1, the teacher's residual average is among the top 25% of teacher averages in the district, and if below –1, among the bottom 25% of teacher averages. A handout explaining residual analysis and the school effectiveness index has been prepared and widely distributed.

The survey and observation results were shared across the district and the state. Key conclusions about the most effective teachers of this study were that they:

- focused on the delivery of biology instruction.
- resisted distractions from their classroom efforts.
- maximized student use of class time.
- studied and planned with other teachers using the North Carolina Biology Standard Course Of Study.
- focused all student time on the Standard Course of Study goals.
- planned students' activities that are always under teacher control.
- used data to guide their instructional practice.

Key conclusions about the least effective teachers of this study were that they:

- had less focus on Biology.
- spent less time on planning.
- planned alone and used prepared lessons from the district pacing guide.
- took less time to prepare their own lessons.
- used a wider variety of activities in the classroom and had students spend more time in student led activities.
- were not always focused on the Standard Course of Study.

DISCUSSION

The findings of this study concerning teacher directed use of time in alignment with a curricular focus has been supported by many earlier research studies (Anderson & Walberg, 1994; Frederick, 1980; Frederick & Walberg, 1980; Walberg, 1999; Walberg & Frederick, 1991). The predominant use of direct teaching as an effective tool in promoting student learning is also well documented in the research (Gage & Needles, 1989; Walberg, 1999; Wang, Haertel, & Walberg, 1993a, 1993b).

Berlin's (1993) essay, *The Hedgehog and the Fox,* as explained by Collins (2001) can also be used to describe the top teachers as focused "hedgehogs" with a single-mindedness of purpose contrasted with the bottom teachers as foxes, whom Collins (2001) writes, " pursue many ends at the same time" (page 91). Hedgehogs are more likely to produce quality results because of their focus on the goal (one goal).

Yet these are general conclusions, and there was a top teacher and a bottom teacher in the study who were exceptions to each of these conclusions. The largest impact of this study may be found in the discussions around classroom practice that have begun. Teachers have either been validated in their practice or have been shown that there are teachers who are producing more growth in students. Middle and bottom teachers can no longer say that their students are doing the best that they can; now these teachers know that there are similar students performing better in other classes. These teachers have been provided with a vision of better performance, thus creating possibilities for improvement.

Two schools in the district with low biology effectiveness indices and teachers with low middle to bottom average residuals has begun biology improvement cycles. They have contacted three schools with higher effectiveness indices and are using the information gained from these schools and their own residual averages to drive their improvement. This effort models for our district the beginnings of practical use of this new value-added instructional improvement analysis model piloted by this study.

IMPLICATIONS

This research made a connection between test scores and classroom practice that had been lacking. Effectiveness indices and average student residuals are now beginning to be seen as indicators of where to look for best practices and models for improvement beyond a classroom and a school. Conversations have begun that break through the isolation that teachers and administrators sometimes feel.

The challenge now is to find ways to help teachers find time to study their data, plan together, and to engage in these discussions. There is also the need to move more of this information to the classroom, as not all principals and schools are using the residual data. Since the most effective teachers resist distractions from class time, the curriculum specialists need to look for unintrusive ways to share the practice of these teachers. School-wide improvement projects need to documented and later shared.

The survey and observation procedures can be improved in upcoming studies. Some of the survey questions did not provide useful insights, and there were questions that arose but could not be answered by the instruments of this study. A recently initiated Algebra I study will look more deeply into classroom practices. A survey and classroom observations will assist to study the use of research-based strategies (Marzano, Pickering, and Pollock, 2001). Class size and number of student contacts will also be studied.

This study is the first step in a district-wide school improvement effort that will seek to identify best teaching practices. Sharing across schools will become the norm, not the exception. A good district can become a great district. As Collins (2001) writes, “Greatness, it turns out, is largely a matter of conscious choice” (p. 11).

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