DATA ANALYSIS AND THE PRINCIPALSHIP

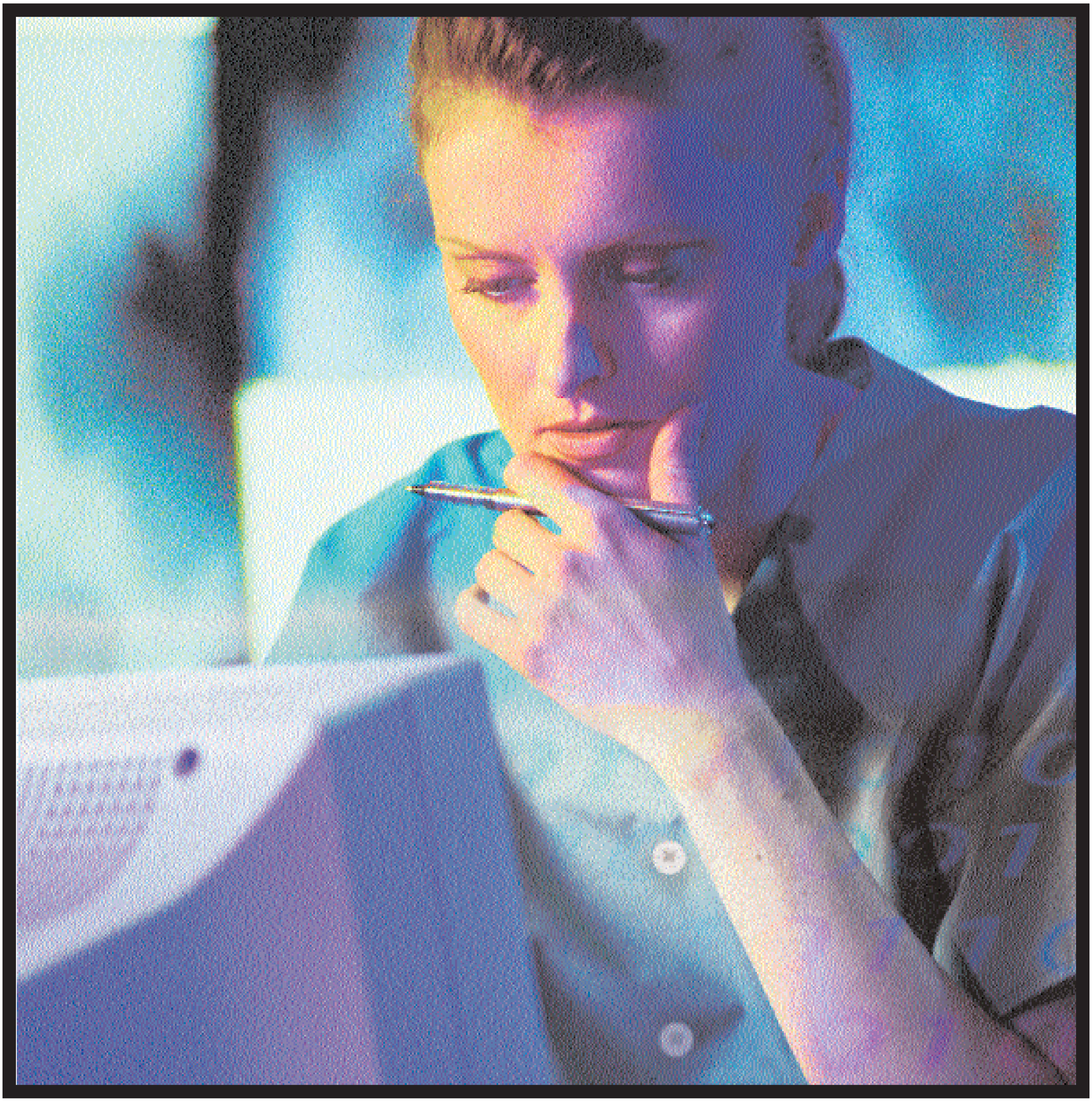
Data-driven decision making is a hallmark of good instructional leadership. Principals and teachers can learn to maneuver through the statistical data to help create goals and strategies for change and improvement.

By Theodore B. Creighton

Few things are more feared than statistical analysis. Many school leaders make decisions about instructional leadership by using their intuition and shooting from the hip, rather than considering data collection and data analysis. But meaningful information can be gained only from a proper analysis of data, and good decisions are based on this thoughtful process of inquiry and analysis. School districts across the United States collect and maintain many forms of educational data (e.g., attendance rates and standardized and criterion-referenced test scores); nevertheless, most schools use the collection of these data to satisfy administrative requirements, not to assess and evaluate school improvement. Standardized test scores are generally reviewed only briefly until the local newspaper calls. Average daily attendance is reported to state education agencies, then filed away. Educators rarely examine these data to assess the quality of teaching and learning at their schools.

To most educators, statistics means endless calculations and formula memorization. Statistics is perceived as the formal domain of advanced mathematics and as a course taught by professors who desire to make their students' lives as painful as possible. Such courses usually focus on formal proofs of mathematical theorems and the derivation of statistical formulas. Contrary to popular opinion, if someone has passed a high school course in elementary algebra, he or she has the knowledge and skills required for understanding statistical analysis.

Educators' fears of statistics likely relate to a variety of factors, but principal and teacher preparation programs must accept the fact that the presentation of statistics in education probably lacks four important components. First, it does not emphasize the relevance of statistics to the day-to-day lives of principals and teachers. Second, it does not fully integrate current technology into the teaching and



learning of statistics. Third, few (if any) statistics courses are designed for students enrolled in education leadership or teacher education programs. Fourth, many statistics courses taught in colleges of education focus on inferential statistics as a tool for conducting research projects and dissertations. Far less time is spent on statistical strategies that might help principals improve their skills in problem analysis, program and student evaluation, data-based decision making, and report preparation.

Relevance

Students in traditional statistics courses frequently ask, "When will I ever use this stuff?" Most statistics courses at the college level are taught as hard-core math, devoid of powerful and practical applications relevant to school administration and student learning. Many educators seem to realize the importance of relevance in instructional courses but have been slow to incorporate the same level of practical application to statistics and research courses.

Technology

According to McNamara and Thompson (1996), applied educational statistics instruction must move away from the traditional conception of statistics as mathematical theory and approximate administrator and teacher preparation programs. The advance of technology and the large ➤

selection of user-friendly computer software can facilitate more practical and relevant presentations of statistics for educators. Several good statistical software packages exist—for example, GB STAT and the Statistical Package for the Social Sciences (SPSS). Better yet, educators can use Microsoft Excel to perform data analysis. All are easy-to-use, menu-driven statistical programs applicable for analyzing student standardized test scores, attendance and drop-out data, college entrance requirements, and the like. These common computer software programs can tabulate the number of males and females in a school, calculate average grades of the students, compare test scores by sex, determine whether a statistically significant difference exists between academic achievement by athletes and nonathletes, compare computer-assisted instruction with other methods of delivery, and test the effectiveness of whole language versus phonics instruction.

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Statistical Analysis Designed for Educators

Many courses in statistics emphasize and concentrate on psychology, sociology, and other social sciences with little mention of ways that statistical analysis can assist school principals in their day-to-day decision making. Educators work with data collected from real classrooms and focus on student instruction and assessment, attendance and drop-out rates, college entrance tests, and instructional program evaluations.

Although inferential statistics are more likely to be used in research studies and dissertations, descriptive statistics are more likely to be used in the schools. Descriptive statistics help us describe those studied (percentile ranks, means, median, modes, range, standard deviation), and inferential statistics use sample data to estimate parameters and test hypotheses. In most cases, educators encounter data that are related to whole populations rather than samples (part of a population). In other words, the data educators encounter are collected from entire classes or grade levels, entire building populations, and entire district populations. Principals are not interested in generalizing their school data findings to other schools or estimating parameters and testing hypotheses. Their immediate interest is in data from their school for the current academic year. I advocate a shift in the education of statistical analysis from the traditional research and dissertation model to one of relevance and applicability to administrators and teachers.

What Is Statistics?

It's not advanced mathematics. The majority of statistical analyses that are useful to the principal can be completed with a basic understanding of mathematics. Statistics is a set of tools designed to help *describe* the sample or population from which the data were gathered and *explain* the possible relationship between variables.

For example, a school principal wonders whether the mathematics instruction in his school is being taught in an equitable manner. A simple statistical procedure called the *Pearson correlation* can help identify a relationship between math scores and sex. If the results of the analysis indicate a pattern of boys receiving higher scores in mathematics on standardized tests, the principal may want to look more closely at classroom instruction to determine whether instructional strategies can be altered to address the equity issue.

A school principal wants to know whether there is a relationship between students' performance on the district writing assessment and their socioeconomic levels. In other words, do students who come from lower socioeconomic backgrounds perform lower, as we are led to believe? Or are there other variables responsible for the variance in writing performance? Again, a simple correlation analysis will help describe the students' performance and help explain the relationship between the issues of performance and socioeconomic level.

Data analysis does not have to involve complex statistics. Data analysis in schools involves collecting data and using that data to improve teaching and learning. Interestingly, principals and teachers have it pretty easy. In most cases, the collection of data has already been done. Schools regularly collect attendance data, transcript records, discipline referrals, quarterly or semester grades, norm- and criterion-referenced test scores, and a variety of other useful data. Rather than complex statistical formulas and tests, it is generally simple counts, averages, percents, and rates that educators are interested in.

So, What's the Problem?

In *Getting Excited About Data*, Edie Holcomb (1999) discusses the reasons why data are little used in schools and why it is so difficult to generate passion to get educators engaged:

> My observations are that more than half of our teachers have graduate degrees and have taken at

ANOVA MATRIX, INSTRUCTIONAL STRATEGY BY CONTENT AREA

	Math	Reading	Science
Cooperative Learning	Scores for students in math with cooperative learning	Scores for students in reading with cooperative learning	Scores for students in science with cooperative learning
Direct Instruction	Scores for students in math with direct instruction	Scores for students in reading with direct instruction	Scores for students in science with direct instruction

Each cell in Figure 1 contains a separate group of students tested with the same dependent variable (a standardized test). The ANOVA allows us to test the mean differences between these six instructional situations. We are looking for any statistically significant difference among the six groups.

Figure 1

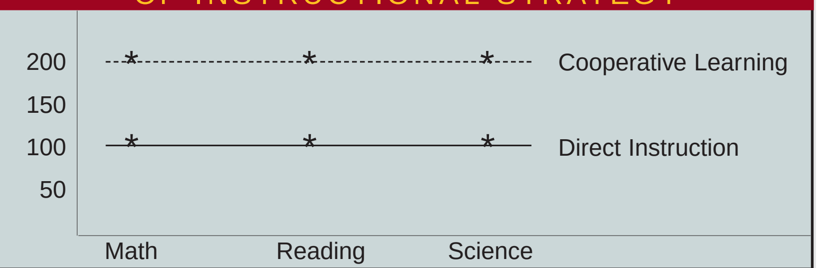
least one course in tests and measurements or statistics. I have four graduate degrees myself and can recall no class discussion of what to do with assessment information in planning how to help students do better. I have come to the conclusions that such courses are taught by researchers as though they are preparing researchers.

As a result, the emphasis is on esoteric experimental design—which can't be replicated in a normal school setting. (P. 22)

Holcomb continues by quoting Gerald Bracey (1997), internationally recognized as an expert on the understanding of education statistics:

Many of the university professors who create and use statistics are more comfortable using them than they are teaching other human beings what they mean. And in all too many instances, statistics are taught in a theoretically rarefied atmosphere replete with hard-to-understand formulas and too few examples to the daily life of education practitioners.

MAIN EFFECT DUE TO TYPE OF INSTRUCTIONAL STRATEGY



Note: * represents test mean scores of 200 for each of math, reading, and science utilizing cooperative learning strategies and mean scores of 100 for each of math, reading, and science using the direct instruction strategy. Direct instruction is represented by the solid black line, and cooperative learning is represented by the dashed line.

Figure 2

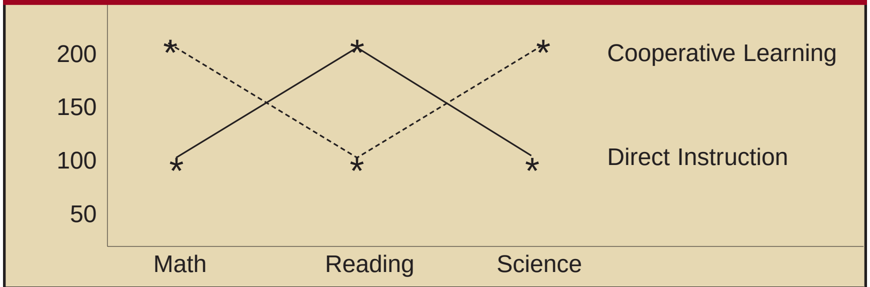
Using Data Analysis in the Principal's Office

Example One. Data analysis and statistics that foster school improvement must be more understandable and useful to educators in schools. For example, analysis of variance (ANOVA) is a procedure for evaluating the mean differences between two or more samples, similar to a t test. The difference between an ANOVA and a t test is that the t test is an appropriate procedure for no more than two samples. The ANOVA permits comparison among many variables at one time, allowing for much more flexibility. And educators must look at many variables (e.g., socioeconomic status, limited English, and special education).

Let's start off with what seems to be an oxymoron: the formulas and calculations of the ANOVA are quite complicated, but the concept of the ANOVA is simple. Further, if someone has a conceptual understanding of the process of the ANOVA, he or she can use one of many user-friendly computer software programs to perform the procedure with a few keyboard strokes.

Suppose we want to look at the effects of two instructional strategies: cooperative learning and direct instruction. But we realize that the results might vary according to the variety of courses taught. In other words, maybe cooperative learning strategies work better in math classes than in language classes. Figure 1 shows two instructional strategies and three subject areas, forming six groups (samples) of students to be evaluated. You can guess what our questions might be. Is there any difference between the two instructional strategies? Does perhaps one strategy work better in math instruction whereas another works better in science? We might find evidence to support the use of cooperative learning in all three content areas (main effect). If this were the case, there would be no interaction between the two instructional strategies. ➤

INTERACTION BETWEEN INSTRUCTIONAL STRATEGY AND CONTENT TAUGHT



Note: * represents mean scores of 200 in math, 100 in reading, and 200 in science using the cooperative learning strategy and 100 in math, 200 in reading, and 100 in science utilizing the direct instruction strategy. Direct instruction is represented by the solid black line and cooperative learning represented by the dashed line.

Figure 3

Using hypothetical data, Figure 2 suggests the two instructional strategies differ consistently in student achievement. The subject taught has no effect on student achievement in regard to the method of instruction. Slipping into statistical language for a minute, we can say that observe no “interaction” between instructional strategy and curriculum content.

Again using hypothetical data, Figure 3 reveals that cooperative learning seems to work well in math and science but not as well as in reading. Direct instruction appears to work best in reading but not as well as in math and science. Interaction exists between instructional strategies and course content: some combinations of instructional strategy and subject result in higher student achievement than do other combinations. The ANOVA allows administrators to evaluate the amount of interaction between the two factors.

The ongoing debate over cooperative learning and direct instruction is not unlike the ongoing debate over whole language and phonics or any debate that encourages educators to accept one method or strategy and reject the others. The examples abound: either whole language or phonics; either standardized tests or performance-based assessment; either constructivism or back to basics; either ESL or English only. The list goes on and on. The real strength of the ANOVA test is that it can reveal, as in this hypothetical case, that two seemingly opposing instructional strategies interact more than we sometimes think.

Too often, we do not recognize the strengths of several strategies in combination rather than alone. Collecting sound data and analyzing appropriately will assist principals in their decision making. The above example illustrates how easy it is to use existing data to help us with the day-to-day operation of our school: curriculum, instruction, assessment, and student achievement.

Example Two. You are the chairperson of the Horizon High School Curriculum Committee. The board of education allows only one subject area at Horizon to have new textbooks each year. The director of secondary education in your district wants a recommendation from you and the committee for this year’s textbook adoption. You and your committee must decide which subject area will receive this year’s new textbooks.

Looking at the standardized test scores for Horizon High School, you can use the measures of central tendency and variability to make a wise decision and recommendation to the director of secondary education. Figure 4 displays some of the information we need to address our assignment.

We notice that the mean score for the writing assessments is much lower on average than the other subject areas. In addition, the standard deviation is higher than the others, meaning that the writing scores are a bit more spread out from the mean. The standard deviation is 11.88 (rounded to 12) and the mean is 205.76 (rounded to 206). The 24-point spread represents one standard deviation unit below the mean and one standard deviation unit above the mean. We can say that approximately 68 percent of the high school students scored between 194 and 218 on their writing assessment scores.

The scores of the other subject areas are noticeably higher and the standard deviations a bit smaller, indicating that those scores are centered a more closely to the mean. Although we need to take many other factors into considera-

HORIZON HIGH SCHOOL: DESCRIPTIVE STATISTICS

	N	Minimum	Maximum	Mean	Std. Deviation
MATH	100	234	263	246.86	7.69
LANGUAGE	100	232	260	248.26	6.38
SCIENCE	100	220	276	245.41	8.51
WRITING	100	175	234	205.76	11.88

Figure 4

tion, the writing scores would give us reason to suggest purchaising new instructional materials for that subject area.

Conclusion

Collecting data without purpose is meaningless. Using the many different kinds of data collected in schools to help make decisions legitimizes the goals and strategies educators create for change and improvement. These data help us identify groups of students who are improving and groups of students who are not—and help to identify the reasons. Data-driven decision making and instructional leadership must go hand in hand.

It is no secret that our profession is under careful scrutiny by our national and state legislators, communities, and, yes, the universities. I cannot imagine a better time for us to consistently use data to improve decision making in our schools for the benefit of our students. Yes, it is time consuming and, in some cases, costly. But what's our choice?

Until we begin to seriously evaluate and analyze the data that exist in our schools, our profession will continue to be scrutinized and questioned with regard to student achievement and quality teaching and learning. Evidence indicates that public schools are losing some of our market share to private schools, vouchers, charter schools, and some emerging for-profit enterprises. We must discontinue the practice of making decisions based upon intuition and gut feelings.

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Original example from Mark Richardson's class notes Principal Component Analysis. What if our data have way more than 3-dimensions? Like, 17 dimensions?!Â Here's the plot of the data along the first principal component. Already we can see something is different about Northern Ireland. Now, see the first and second principal components, we see Northern Ireland a major outlier. Once we go back and look at the data in the table, this makes sense: the Northern Irish eat way more grams of fresh potatoes and way fewer of fresh fruits, cheese, fish and alcoholic drinks. It's a good sign that structure we've visualized reflects a big fact of real-world geography: Northern Ireland is the only of the four countries not on the island of Grea