Achieving Excellence Through Outcome-Based Instructional Delivery

The Center School in New Canaan, Connecticut, has raised achievement by grouping students according to skills they are ready to learn and by teaching for mastery.

STEPHEN E. RUBIN AND WILLIAM G. SPADY

No one approach to education can possibly solve all of the disagreements concerning learning outcomes for students. There is, however, a small, common set of problems that most schools desire to address:

1. Wide differences in the cognitive and social skills students bring with them.
2. Wide differences in the rates at which students learn.
3. Wide differences in the subject matter and pedagogical skills of teachers.
4. Serious constraints on teaching time.
5. Serious constraints on the capacity of the school to deliver instruction to individual students consistent with both their level of learning and their rate of learning.

Despite these differences and constraints, schools are expected to produce levels of learning in all students that satisfy the public's expectations for minimum standards while providing maximum challenges. Doing one without the other leaves the school open to criticism for neglecting the needs of the less able—because a fixed rate of program delivery allows them to flounder in the wake of faster learners—as well as the more able—because the limited focus and pace of instructional delivery prevent them from learning more.

Instructional Delivery for Promoting Excellence

Clearly what is needed to address this dilemma is an approach to instructional delivery that:

1. Accommodates variability in student achievement and aptitude.
2. Increases the amount of time students receive instruction targeted to their particular learning styles and needs.
3. Enables teachers to focus their time and attention on reasonably large groups of students who can directly benefit from their instruction.
4. Reduces the serious burdens and distractions inherent in most "individ-

Stephen E. Rubin was Principal, Center School, and is now Assistant Superintendent, New Canaan, Connecticut, Public Schools. William G. Spady is Laboratory Director, Far West Laboratory for Educational Research and Development, San Francisco.

Authors' Note: *The dedicated and able faculty and staff at the Center School deserve the praise of all who believe that change for the better is possible. They dared to be different and have made it work beautifully for themselves and their students.*

ualized" and "learner responsive" instructional systems related to testing, record keeping, and managing the reassignment of students to new learning groups or tasks.

5. Enables students to receive the benefits of curricular units carefully sequenced according to hierarchy of skills and concepts, and diagnostic evaluation based directly on those skills and concepts.

Such an approach would enable students to receive individualized mastery learning instruction without compelling teachers to apply new and complex teaching, testing, and classroom management skills to large numbers of students individually. It would also increase the amount of time students receive instruction targeted to their skill levels and ability to handle new challenges—conditions that Fisher and others (1978) call academic learning time, the type of time–on–task that yields payoffs in terms of student achievement. This approach—*outcome–based instructional delivery*—can elevate achievement levels of students from any ability group well beyond what they might accomplish under other whole–group instructional conditions (Spady, 1982).

The term "outcome–based" refers to a variety of instructional systems in which the specific learning achievements of students—rather than predetermined time and schedule factors—govern their placement and movement through the curriculum. In such programs, students are flexibly grouped according to the specific levels of achievement and curriculum challenge they have the prerequisites to handle. These are called "task assignment" groups. They differ dramatically from conventional "program assignment" groups, to which students are permanently assigned according to age, "ability," or interest, and receive instruction focused on general group needs.

The outcome–based delivery model used at Center School in New Canaan, Connecticut, presents student achievement results that suggest both the model's power and its feasibility in other public school settings. It can be used in many curriculum areas and at many educational levels, including graduate–level courses and military and industrial training.

The Center School Mathematics Program

Center School has 16 classroom teachers and a heterogenous population of 400 K–6 students from a middle–class community. The intructional delivery system used in its mathematics program embodies all of the features just discussed and leaves little doubt about the capacity of nearly all students to meet or exceed traditional expectations. The school's reading and writing programs are also organized and delivered in ways similar to the mathematics program, also with very positive results.

Mathematics Achievement at Center School. Data from the school's mathematics program for the past six years indicate that the delivery strategy enables all students to advance through the curriculum as rapidly as their aptitudes allow, with the following results:

1. Between 10 and 20 percent of the 6th graders each year complete the equivalent of the first half of Algebra 1, and many of them have completed the entire course (solving quadratic equations using four different modes of solution).

2. No more than one or two students per year in the entire school failed to reach grade level on standardized mathematics tests (including mildly handicapped students).

3. In 1981, a representative year, over half of the 6th graders and over one quarter of the 5th graders scored 12.9 (or 99th percentile) on the Metropolitan Achievement Tests in Mathematics; 6.3 was the lowest score recorded by any 6th grader, and 5.9 was the lowest for any 5th grader.

4. Based on the 1981 6th graders' IQ's, their predicted quartile break scores on the Metropolitan were 5.9, 7.0, and 7.9, but their actual achievements were 9.1, 12.9, and 12.9, respectively.

5. By March 21, 1983, almost 20 percent of the 6th graders were working on Algebra 1 content, and another 36

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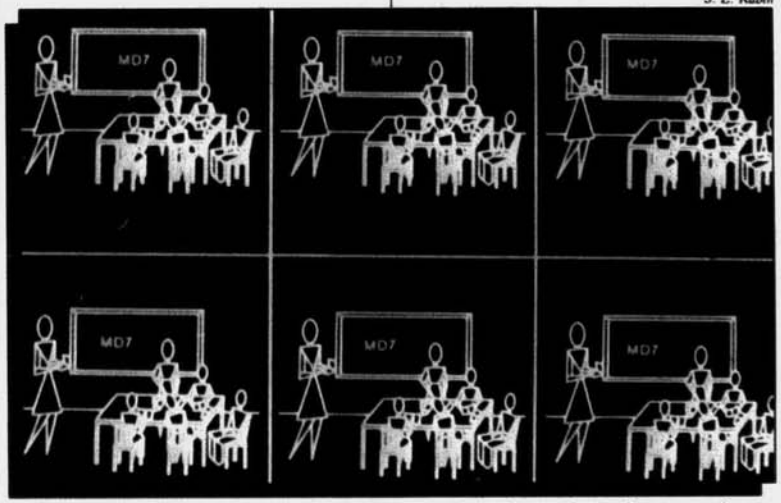
S. E. Rubin



The boundaries of the classroom have now been changed in order to bring together students who share a similar instructional need.

percent were working on integers and order–of–operations objectives found in typical pre–algebra texts.

Task Assignment Grouping. This mathematics program closely parallels the system of instruction found in most ski schools. Typically, ski schools organize each of their instructional groups according to two criteria:

1. Everyone in an instructional group shares a common need to learn the same thing at the same time, and the group is formed around that specific skill, objective, or outcome (for instance, everyone needs to learn snowplow turns).

2. Everyone in an instructional group has already mastered the objective that is prerequisite to learning this new objective (snowplow stops).

Skiers in any one class may vary in age, ability, previous experience, socioeconomic level, motivation, and the rate at which they are likely to learn the skill in question, but they are assigned to the same class because they *all need to learn the same new task at this time.* When one of them learns this task, that person is reassigned to a new class on a new slope to learn the next step to effective skiing. Similarly, new students move into the class as they master its prerequisites.

Highly Focused Instruction. By applying this "task assignment" grouping approach to the program in Center School, the staff organizes instructional classes around students from different age and ability groups who share a congruent instructional need—for example, "how to add fractions." The criteria for including students in such a group are:

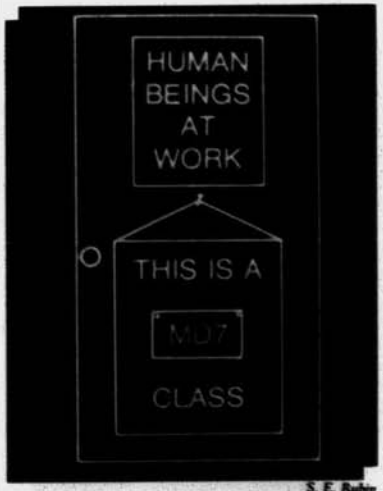
1. The student has not yet learned (mastered) how to add fractions with dissimilar denominators; and

2. The student has learned (mastered) the objective (skills) that are prerequisite to adding fractions with dissimilar denominators.

Instruction is highly focused and efficient since the groups are formed around specific learning objectives or outcomes, and the students in those groups are ready and able to learn the new objective because they share a congruent need to learn this objective and have already met the necessary prerequisites. Because of this careful assignment based on task needs, virtually everyone in a given class is truly ready to learn the same thing at the same time. Under these circumstances teachers can focus on the instructional needs of all their students simultaneously since the range of need is quite narrow. In addition, pupils work with each other and with their teacher in a social setting rather than having to learn through nonhuman sources such as "individualized instructional packets." In fact, under these conditions teachers are much more likely and able to use a wide variety of instructional materials and methodologies—adjusting them to individual *learning styles*—since the restricted range of learning needs enables them to focus more readily on additional learning variables.

In this system, gifted students move as quickly as they need to, and the learning disabled don't get pushed along in confusion; both find themselves in each other's company at different times during the typical year. However, since both groups learn within the same structure and the same system, albeit at different rates, neither is segregated or separated into a different program and no clearly defined goup of students falls behind or receives "remedial" instruction outside of the regular program.

Accommodating such large differences in learning rates is possible because of the built–in management and decision–making tools that permit the flexible and continuous reorganization of instructional groups. These tools are major keys to this student–responsive delivery system.



S. E. Rubin

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The Management of Tools of the System

Mathematics Objectives. The mathematics objectives in the Center School system presently span a range from pre–kindergarten knowledge (such as relative size of objects and numbers) to the end of Algebra 1 (that is, solving quadratic equations using all four methods of solution). Over a period of 18 years, 231 "packages" or clusters of objectives have been defined and refined to cover this range of skills. Each package or "terminal objective" contains approximately four objectives, although particular packages vary from one to eight objectives.

Testing and Evaluation Instruments and Procedures. Center School's curriculum is congruent with its testing program. Each student is first evaluated on all elements in the instructional program in order to determine what he or she knows, and nothing is evaluated or tested that is not a part of the curriculum and instructional program. Consequently, the program has developed 231 test instruments or procedures to evaluate the 231 terminal objectives included in the curriculum. Each of these tests and evaluation procedures meets four criteria:

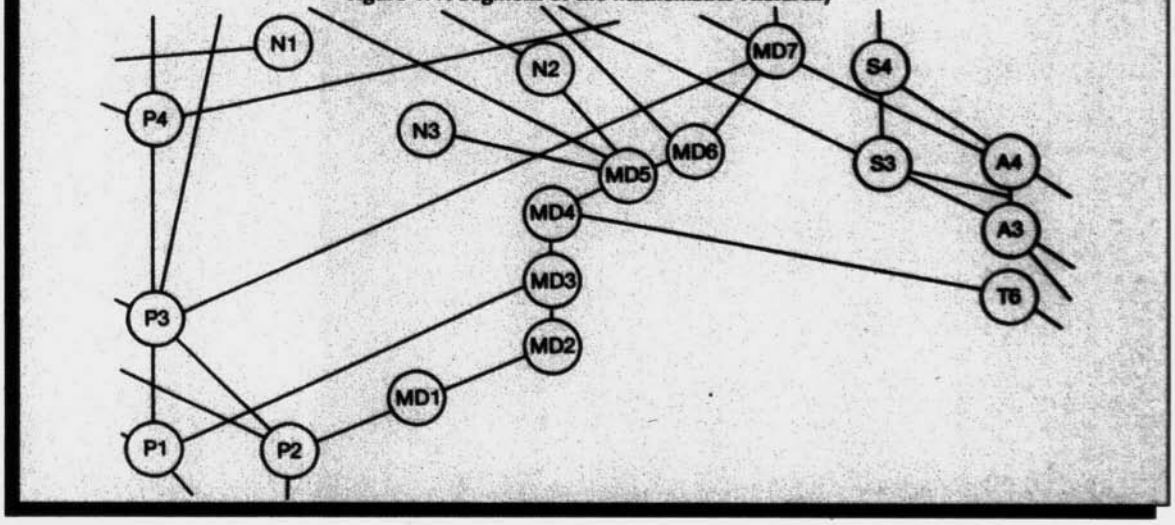
- *Validity*—Content validity is built into the series of test instruments since there is one criterion–referenced test or evaluation procedure for each separate objective in the program. Each instrument focuses explicitly on the content and level of difficulty of a particular objective in the curriculum. The tests differentiate between students who really know the objective from those who do not.
- *Reliability*—The reliability or consistency of measurement has been refined and continually improved. When needed, alternative forms of each criterion–referenced test are constructed in the Testing and Evaluation Center using methods designed to ensure high internal consistency.
- *Discrimination*—By observing items that actually discriminate and by factoring out items that do not adequately discriminate between students who know an objective from those who do not (either because the items were too easy, too hard, or too ambiguous), we have improved the discrimination power of our tests over the years.
- *Efficiency*—By using highly valid and powerfully discriminating items, the program keeps its tests as short, or "efficient," as possible without compromising their ability to measure the skills they are supposed to measure and to discriminate between students who know the objective from those who do not.

The program also distinguishes between "tests" and "testing procedures." While schools usually use paper–and–pencil "tests" to assess student knowledge, there are certain applied performance objectives in every program that cannot adequtaely be measured using such methods. Thus, when measuring a student's ability to perform or do something physically, for excample, the Center School staff use "a criterion rating scale" that enables different raters (teachers) both to observe and to assess the performance in a similar manner.

The Validated Hierarchy of Mathematical Objectives. Once the Center School staff determined what objectives they wanted to include in the math curriculum, they also recognized that these discrete objectives needed to occur in some sequence, and that the sequence was not to be arbitrary. Learning objectives that are "ordinal" (subordinate and superordinate to others) create a "hierarchy" of dependencies. Frequently these ordinal relationships can be arranged into a nonlinear pattern that can be represented graphically.

When we began to develop and organize these objectives in 1964, we could at first only assume that certain hierarchical relationships existed, based on our own experiences in mathematics. In order to validate this initial hierarchy, we subjected our assumptions to empirical testing by using a large and representative sample of students. Over a period of years, students were tested on each of the objectives in the program. When the data were analyzed using a multivariate factor analysis, we were able to determine that there were statistically high enough probabilities of rela-

Figure 1. A Segment of the Mathematics Hierarchy



tionship among certain objectives to classify the pair as representing a dependency relationship at the .05 level of confidence. That is, within these statistical limits, learning one objective was sometimes dependent upon knowing another. It was simply highly unlikely that students could succeed at one of them without first learning the other.

Each time we discovered such a significant relationship, we were able to represent that understanding graphically by connecting the two circles representing the two objectives to each other by a line between them. The sum total of all the documented significant relationships among these 231 clusters of objectives could then be graphically represented as an empirically validated hierarchy. That graphic hierarchy represents a "causal map" of our mathematics curriculum and is used as both a record of student progress and as a decision–making tool for student assignment (Figure 1).

The Computer Management System. The fourth major management and decision-making tool in this system is the computer software that simplifies student record keeping and program coordination. The software is currently available on a single disc and contains the entire hierarchy of 231 objectives and the capacity to keep detailed records of each student's performance profile, including the date each student began working on each objective, the date he or she completed each objective, the date(s) of testing for the objective, the test score, the name of the teacher who taught the objective, a qualitative assessment of the student's work for that time period, the objectives for which the student is now eligible, and the prerequisite tests the student must pass before beginning a new objective.

In addition, the software automatically compiles lists of students who are eligible for particular objectives so that the program coordinator can adjust the schedule of teacher assignments to meet the greatest areas of student need. It also maintains an up–to–date composite list of all students in each grade level, ordered and divided into quartiles according to the number of objectives that each has accomplished; and it automatically flags any student who has been working on an objective longer than an (empirically derived) expected number of days. This enables staff to be alerted to those who may be falling behind on a day-to-day basis and to give them special assistance if needed.

The Operation of the System

Forming Classes Around Task Needs. A validated hierarchy can be a powerful decision–making aid since it enables instructional managers to redefine the boundaries of instructional groups with continuous flexibility. Students can be brought together into the same class because they share the same instructional need at a particular time.

Let's assume, for example, that Terry, a student, has learned and mastered the objectives we call P1 and P2, but not objective P3. According to the part of our mapped hierarchy represented in Figure 1, she is "eligible" to learn P3 since P1 and P2 are the only two prerequisites or *immediately subordinate objectives* she would have to know before being able to learn P3.

Now, just as in the ski school where she might have been placed in a "snowplow turn" class, Terry enters a class where everyone shares the same need for the same type of instruction, P3. Students in this P3 class may represent different ages, different abilities, different sexes, different grades, and probably different mathematical backgrounds. Hence, it is not a class for "bright" students or for "average" students or for "learning disabled" students; nor is it an

"ability–grouped" class. But these students do share two very important attributes. First, they all *need* to learn P3 since none have this knowledge as yet, and second, they are all *able* (and therefore "eligible") to learn P3 because they have all mastered P1 and P2.

In terms of conventional "program assignment" grouping methods, this represents a most unusual class, but it is homogeneous in the same important way as ski school classes. Since everybody in this class *needs* P3 instruction, the instructor can appropriately focus on this limited set of instructional needs *without* fragmenting efforts to deliver multiple types of instruction simultaneously. Note, too, that in this program teachers are no longer taken away from their students nor replaced by "learning packets."

How long Terry will remain in the P3 class depends on her continuing need for the type of instruction being offered in that group. She will stay there as long as the instructor feels she continues to need that particular instruction. A time will come when sufficient learning has taken place, although that moment inevitably varies from individual to individual. At Center School, Terry may leave the P3 instructional group when she demonstrates mastery of the objective; her movement from the group will not be accelerated or delayed by others learning at different rates. In this program no student forces or compromises the development of any other student.

Evaluating Mastery at Different Times. Typically, Terry's teacher would initiate this phase when Terry's classroom performance suggests that she has learned the objective, although Terry could do so as well. She must demonstrate that her level of mastery offers some degree of assurance that she will succeed at the next goal. At Center School, assessing competency occurs in a centralized Testing and Evaluation Center, apart from the instructional site. This Center, staffed by aides, allows testing conditions to be uniform, and frees teachers from this noninstructional (paper work) responsibility. In other words, *the primary function of the instructional site is to provide instruction and to prepare students for competency.*

Recording Progress and Record-Keeping. The hierarchy itself is used to record continuing information about each student. Circles denoting the objectives are simply "colored in" on each student's hierarchy map as he or she demonstrates new competencies on specific objectives. When Terry first entered Center School, for instance, she was evaluated to determine the extent of her "entering knowledge," and the appropriate circles were colored in accordingly. After that, it was simply a matter of continuing to have an aide "color–me–competent" as Terry gained specific new knowledge and demonstrated mastery. By alternating colors from grade to grade, staff members can easily identify when particular knowledge is developed. Therefore, it is entirely possible to graphically record and chronologically trace the development of a student's precise mathematical knowledge from kindergarten through high school algebra on *one* piece of paper!

In addition to this profile on the hierarchy, the program also maintains a significant amount of backup data as a supplementary history for each student in the core memory of its microcomputer.

Selecting a New Objective: Decision Making and System Management. Once Terry demonstrates mastery of an objective at the Testing and Evaluation Center, she is sent to the program coordinator who selects a new and appropriate objective for her to pursue from among the entire range of learning options currently being taught. In order to do this, the coordinator must know exctly what each teacher is presently doing, avoid assigning Terry to a class that is working on an objective she has already mastered or for which she lacks one or more of prerequisites.

This requires the coodinator to match the current schedule of math instruction with Terry's profile, thereby tracing which options are theoretically open to

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her. Typically, Terry is eligible to start learning ten to 15 different objectives at any given time. This "theoretical" array of options becomes "real" when the coordinator matches something on this list with objectives presently being taught. Since Terry can learn only one objective at a time, the coordinator must simply identify any one objective she needs from the schedule of objectives taught within the total system. This enables Terry to move through the program with virtually no delays and to pursue other objectives at some future point when the schedule permits.

Optimum Routes Through the Hierarchy. Making decisions about the optimum routes through the hierarchy requires some experience along with a basic understanding of the curriculum's critical paths. For example, we might arrive at the following conclusions from examining the small section of the hierarchy represented in Figure 1:

1. It is more important to learn P3 than N3 since P3 is a prerequisite for four other objectives (four lines emanate from P3 up to other objectives), while N3 leads to no other objective (it is a terminus point).

2. After learning P2, a student has the option of learning P3 or MD1 (assuming the student also has previously mastered P1).

3. After learning MD5, a student has the option of learning any one of four objectives, one of which is not shown in the figure.

4. All things being equal, a student should be directed to learn MD6 before learning N3 since two paths open up rather than none.

Thus, having completed P3, Terry *might* be assigned to an MD7 class already in progress, provided that another set of conditions is met.

Assessment and Review of Prerequisites. Before setting off to learn MD7, Terry will be pre-tested with an instrument designed to *re–assess* whether or not she has *retained* all the prerequisite knowledge. In other words, although Terry's profile may now indicate that she has "mastered" P3, MD6, and A4 (the three objectives described in the hierarchy as the subordinate prerequisites for P3), she may have forgotten something she once "knew." Although it is unlikely that she has already forgotten P3, she may not remember MD6 or A4 since she studied them some time ago.

Hence, the Center School program constantly adapts to one of the realities of instructional systems: "forgetting." The staff believes that student forgetting should not indict the learner, the teacher, or the system but is instead a natural and expected aspect of the learning process. Since staff members expect students to forget some of what they once knew, the program builds in suitable opportunities for them to review and reinforce past learning experiences at the Instructional Resource Center. This Center accommodates idiosyncratic differences in student remembering and forgetting by providing different types of review and reinforcing experiences when necessary before sending them on to a new objective.

Since re-learning and "spontaneous recovery" generally take far less time than was needed to learn and master the material initially, these reviews are brief and selective—"fast cures for minor mathematical ailments" and quick opportunities to regain competency students have temporarily lost. After students regain the necessary prerequisite competencies, they are immediately assigned to classes currently in progress, such as MD7.

Coordinating Instructional Delivery and Staff Assignments. Although this program appears to be enormously complex, it operates smoothly for at least three reasons. First, the *entire* instructional staff, including specialty teachers, is engaged in math instruction for the same one-hour period each day. This means that the complement of teachers available for math instruction is larger than the number of grade-level teachers, and that coordination can be concentrated on a fixed point during the day. The same organizational flexibility can be achieved in secondary schools by block scheduling students throughout different sections of the daily schedule.

Second, the computer software enables the program coordinator to obtain a status profile on the size of existing classes and the size of eligibility rosters at the touch of a button. It is a relatively simple matter to decide which new classes need to be formed and which teachers are likely to be available to conduct them. The assignments are worked out individually with teachers, some of whom prefer to concentrate on certain parts of the curriculum throughout the year while others prefer variety. Remember that some objectives can be mastered by most students in just a few days, making some re-assignments rather frequent; other classes take students considerably longer and give teachers more stability in the short run.

Third, teachers themselves are not burdened with needing to figure out schedules and student assignments or to handle testing. This leaves them free to concentrate on teaching those students assigned to their class on any particular day.

Implications for Implementation

The outcome–based instructional delivery model departs dramatically from the time–honored patterns of whole–group/age–graded, and whole–group/ability–grouped delivery in which the focus of instruction is governed by the capacity of the class to move at a given pace. It also departs radically from a central feature of these models: teachers who work alone with a fixed group of students for an entire year.

Therefore, any model that differs this substantially from conventional practice is bound to be met with skepticism if not outright resistance by teachers and administrators, making its implementation highly problematic despite the obvious benefits to students from all ability levels. Nevertheless, four ponts about the Center School model work to the direct advantage of teachers. Hopefully these points can be used to bolster the implementation strategies of districts desiring to improve the achievements of their students in any subject area in which a hierarchy of skills is implied or can be developed.

1. *Greater Freedom to Teach.* The Center School model gives teachers the opportunity to focus their attention on

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teaching and to experience on a frequent basis the tangible results of their efforts. The clearly defined hierarchy and accompanying tests allow teachers to concentrate on using and refining the best materials and techniques available. Since the program prescribes no particular text or technique for instruction, teachers are free to use their professional judgment and experience in planning and executing lessons. A collection of potential materials for each objective is available in the Instructional Resource Center for teacher use and modification.

Because the task needs of students in their class at any one time are quite narrow, teachers are relieved of the multiple pressures of task diversity, time and classroom management, and individualization that characterize most classrooms. They are also relieved of the constant pressures of testing, record–keeping, review, and conferencing that seriously eat into instructional time.

2. *Shared Accountability*. Since all students are eligible to learn from any staff member, accountability is shared by the entire staff. Everyone contributes to the success of the student body, and everyone shares in its successes. By having a voice in their instructional assignments throughout the year, teachers can choose to concentrate in areas of the curriculum that they recognize as major strengths.

Because the system takes responsibility for student and program success, there is no attempt to fix accountability on any given teacher. This reduces the danger of defensiveness by indivdual teachers and at the same time keeps potential student–teacher conflicts from festering over a protracted period.

3. *Increased Staff Morale and Cohesion*. By fostering collective responsibility, the Center School model enables teachers to develop an authentic community of professionals. Because the system is a *system* requiring the cooperation, flexibility, effort, and communication of all participants, there is a premium on addressing and solving problems when they arise. There is a high degree of purposeful, instruction-related adult interaction at Center School—an element frequently missing in many schools—which brings with it a high degree of peer regulation and feedback. If someone fails to "pull his fair share," the message is quickly transmitted and received. This, it turns out, reduces the need for administrative intervention which, in turn, further reinforces the vitality and professional independence of the teaching staff.

The bottom line, however, is the program's success. Because the vast majority of students learn so well under this system, their success reinforces the teachers' sense of success and efficacy. The result is a positive team feeling and renewed staff vitality.

Differentiated Leadership Opportunities

The Center School Program also has more opportunities for diversity and career mobility than most schools can provide. Here teachers have the opportunity to perform a variety of tasks during the year if they choose to do so since the system creates the need for differentiated roles and responsibilities. Teachers can spend at least part of the year working as coordinators, resource teachers, evaluation and testing specialists, curriculum designers, and teaching specialists. This diversity of options allows for more variety and challenge and gives each staff member both experience with and an understanding of how each component of the system works best. This, of course, opens the door for further refinement and improvement, which has characterized the model's development and effectiveness over the past 15 years.□

References

Fisher, Charles W.; Berliner, D.; Filby, N.; Cahen, L.; Dishaw, M.; and Moore, J. *Teaching and Learning in Elementary Schools: A Summary of the Beginning Teacher Evaluation Study*. San Francisco, Calif.: Far West Laboratory for Educational Research and Development, 1978.

Spady, William G. "Outcome–Based Instructional Management: A Sociological Perspective." *Australian Journal of Education* 26 (1982): 123–143.