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Organizing for Results in Elementary and Middle School Mathematics

The Muhlenberg, Pennsylvania, School District's long-range plan to revise the mathematics curriculum and improve instruction includes a diagnostic-prescriptive model developed with input from district teachers.

In its 1982 long-range plan for school improvement, the Muhlenberg, Pennsylvania, School District specified as a major target the need to improve mathematical computational skills at all levels. To accomplish this general goal, the district concentrated on four strands of activity:

1. development of a management information system to document indices of student achievement—aggregate group/individual students' scores and a quality control monitoring system tied to specific items on the standardized test used by the district;
2. redesign of the district's planned courses of study in order to integrate the taught, the tested, and the written curriculums;
3. alignment of the "regular" mathematics program with "remedial" mathematics to coordinate skills and content for students who work in both areas;
4. implementation of a diagnostic-prescriptive instructional model within the elementary and middle school mathematics programs.

After describing the district activities related to the first three strands, we discuss the implementation of the diagnostic-prescriptive model and the assessment of the entire project.

Curriculum Revision and Staff Development

During 1982-83, the first year of the Muhlenberg Mathematics Improvement Project, a cadre of elementary and middle school teachers used a taxonomy of the major K-8 mathematics content and concepts (PRIMES 1982-83) to analyze item-by-item the standardized test used by the district.

Each coded test item was then classified into one of three projected levels of mastery. Items that receive extensive coverage in the curriculum, which the teachers coded as group "A," are those that should be answered correctly by 75 percent or more students; items receiving some coverage (group "B") should be answered correctly by 50 percent or more students; and items that receive minimal coverage in the curriculum (group "C") should be answered correctly by fewer than 35 percent of the students. These test items became the foundation of the mathematics curriculum portion of the district's management information system, addressed in strand one of the school improvement plan. Teachers referred to them as they evaluated student performance and made curriculum content changes (strands two and three).

The second year (1983-84) of the project was devoted to refining the coding system; designating test items as A, B, or C; and providing inservice for the remaining faculty members in the use of the PRIMES taxonomy. During grade level meetings at the elementary schools and at department meetings in the middle schools, teachers analyzed the report of student performance on individual test items that was generated by the testing system to evaluate group as well as individual student performance.

During 1984-85 and 1985-86, the district took a number of steps to begin institutionalizing a diagnostic-prescriptive instructional process, noted in strand four of the plan. The first step was to update all mathematics planned courses of study and code them according to the PRIMES taxonomy. Second, the district analyzed and coded (according to PRIMES) remedial materials from the elementary schools' Learning Labs and the middle schools' Mathematics Lab. Third, staff related the district's program for those students identified as needing remediation by Pennsylvania's test of basic skills, Test of Essential Learning and Literacy Skills (TELLS), to the PRIMES base. The next steps were to select a new K-8 mathematics textbook series using the PRIMES database as a point of comparison; to use the district's management information system to monitor student achievement; and to conduct inservice programs on error analysis and other principles and practices of diagnostic-prescriptive teaching.

Implementing an Instructional Management Plan

During the 1986-88 school years, the district implemented a diagnostic-prescriptive instructional model in the remedial programs in grades K-8 and during 1987-88 began implementing

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the model in the regular primary grades, K-2. The model is being implemented in the regular intermediate grades (3-5) during the 1988-89 school year. This systematic implementation plan is designed so that the diagnostic-prescriptive instructional model will accompany the students as they move up through the grades.

Figure 1 shows the decision-making and management processes that teachers use within a curriculum unit. The flowchart contains many of the elements for effective instruction identified as critical by Bloom (1984) as well as many of those in Hunter's (1984) instructional model. Before beginning instruction, the teacher reviews with the entire class the prerequisite behaviors for the unit (initial enhancement of cognitive prerequisites). Next the teacher pretests all students on the terminal objectives for the unit and records the results. Using the district's management system, teachers can easily record (and later identify) which students have "mastery," "readiness for mastery," or "no knowledge" of each objective in the unit.

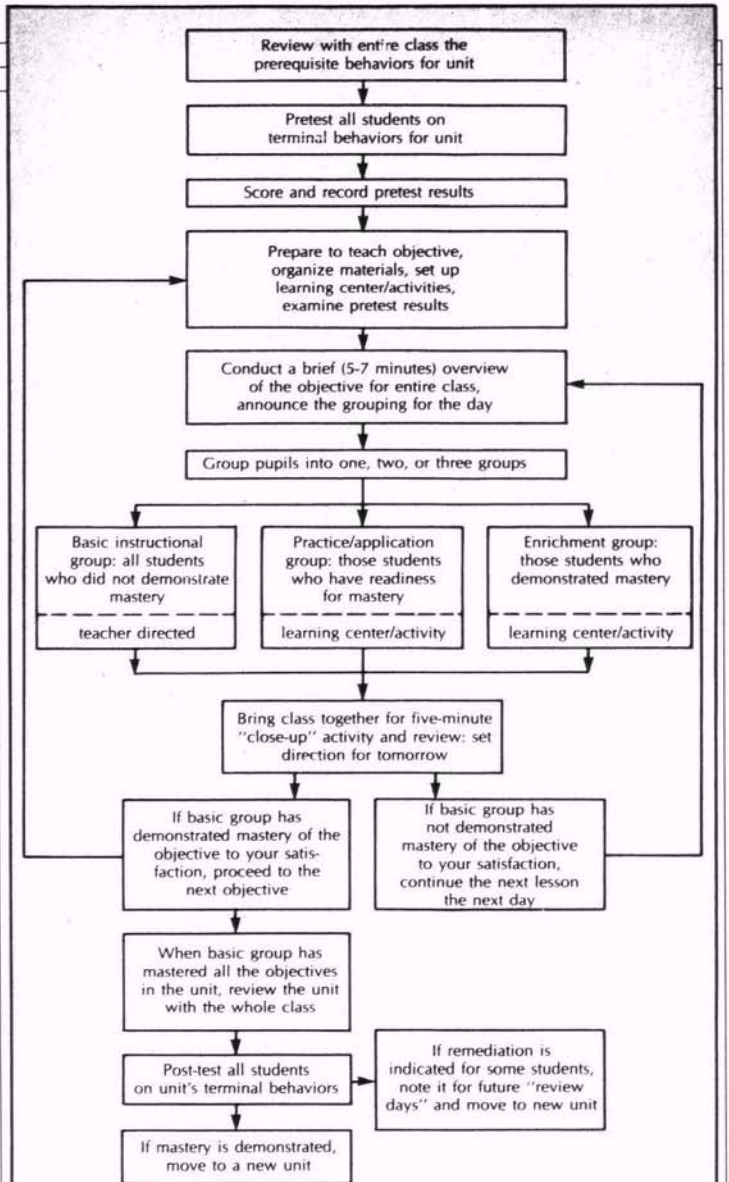

Fig. 1. Teachers' Decision-Making and Management Processes for Flexible Grouping of Students

When preparing to teach any of the unit's objectives, the teacher organizes materials, sets up learning centers and activities, and consults the student performance chart to determine instructional groupings for the day. The teacher begins instruction each day with a brief overview of the objective for the entire class (anticipatory set) and announces the instructional groupings for the day. Those students who have demonstrated mastery of the objective on the pretest—the enrichment group—work at a learning center or some other activity designed to reinforce or extend their knowledge about that objective or to introduce another objective outside the essential curriculum that might be valued by the teacher. The students who have readiness for mastery—the practice/application group—work at more structured activities to help them overcome their demonstrated weaknesses. The students in the basic instructional

group are those who did not demonstrate mastery and need direct instruction and supervision from the teacher. (This group typically receives the direct instruction that all students would receive if the teacher knew nothing about their competence on the objective prior to instruction.) Throughout the class period, the teacher moves from group to group providing instruction, feedback, guidance, and assistance as necessary. Near the end of the period, the teacher brings the students together for a five-minute close-up activity. This close-up activity enables the teacher to summarize what the students studied during the class period, confirm the conclusions that he or she has reached based on the formative data collected while monitoring student progress, and specify the direction for the next day.

If the basic group has demonstrated mastery of the objective to the teacher's satisfaction, the next day's instruction will focus on the next objective. However, if the basic group (or some subset of it) has not demonstrated mastery of the objective to the teacher's satisfaction, the lesson may be continued the next day, with a possible regrouping of students. The teacher continues this decision-making and management cycle until the students have mastered all of the unit objectives. At that time, the teacher reviews the unit with the entire class and post-tests the students on the unit's terminal behaviors. From a management standpoint, most teachers have decided that if remediation is indicated for only two or three students, they will schedule it for future "review days" and move the class to a new unit. If, however, a large number of students still have not mastered an objective, the teacher may spend additional time on reteaching (Nicely 1977, 1986).

By using the PRIMES taxonomy as the basis for analyzing and coding standardized tests, planned courses of study, textbook pages and other instructional materials, and Pennsylvania's test of basic skills (TELLS), district teachers can quickly and easily locate, select, and match materials to objectives. An instructional resources guide (see Nicely 1986) serves as an "action document" for teachers, illustrating how to devote attention to topics such as congruence among written, taught, and tested curriculums; basic skills; differentiated instruction for students; opportunities for cooperative learning within the mathematics classroom; and the identification, acquisition, and use of locally available resources for instruction on each objective.

Grade	Year	
	1985-86	1986-87
3	9%	0%
5	16%	0%
8	11%	9%

Fig. 2. Percent of Students Failing the Basic Skills Test

Monitoring the Project

The Muhlenberg School District is evaluating the achievement of the students as they move through the mathematics program by using a tracking system that focuses on the increment of change in aggregate scores on all subtests of the standardized testing program (Yarworth 1987). That portion of the district's management information system has provided a clear method of reporting test data to teachers, parents, and the board of education.

The students' performance on the state-mandated test of basic skills indicates that the district's efforts have been worthwhile. Figure 2 illustrates how student performance improved during 1986-87, the year in which the diagnostic-prescriptive instructional

model was implemented. Considerably fewer students are failing the TELLS test now than failed it before the intervention (Yarworth 1988). As students progress through the diagnostic-prescriptive programs beyond the primary grades, the district will use its five-year database in the management information system to monitor changes in their scores on the California Achievement Test relative to national norms and their expected scores on the same test measure.

Critical Elements of Change

In reviewing the last five years of change in the district's mathematics program, we note several elements as the keystones to its success.

Faculty preparation for the program. Program planning and development began with a cadre of teachers who had keen interest in improving mathematics instruction and achievement. They became the center of an ever-enlarging series of concentric circles of participating teachers.

Identification of change agent. For a project of this magnitude, a change agent who has the content knowledge to provide expert leadership and will accept project responsibility must be identified. In the Muhlenberg project, the remedial mathematics teacher at the Muhlenberg Middle School accepted the role of change agent, coordinating the training, coding, and follow-up that held the project together.

Appropriate inservice. Inservice began with training participants in the language of PRIMES so that they would have a common vocabulary to discuss mathematics. The next stage required application of this knowledge of PRIMES. Finally, a series of structured activities provided specific data about the information systems. All inservice was done in groups of fewer than 10 teachers on released time during the normal school operating day.

Curriculum coordination. The project has integrated mathematics instruction, diagnosing problem areas for groups as well as individual students, with the revision of the course of study—all with a common vocabulary, PRIMES.

The district's diagnostic-prescriptive instructional model was designed, tested, and modified by more than 100 elementary teachers in Pennsylvania over a period of 15 years.

Instructional model. The district's diagnostic-prescriptive instructional model was designed, tested, and modified by more than 100 elementary teachers in Pennsylvania over a period of 15 years. One of its major components was a classroom organization and management plan (fig. 1) that includes within-class flexible grouping.

Program quality control. The district's extensive management information system gives the faculty a usable quality control system for measuring student performance. The opportunity for change can only be validated when the change is based on data that, in fact, do measure performance. Without continuous monitoring for quality control, random events and instructor caprice may drive the curriculum without any notice that the train has left the track.

The process of change in any curriculum area is difficult, and the road to program improvement may be tread only by changing a faculty's concept of what constitutes the curriculum and the often-complex methods by which it is taught and evaluated. Here we have traced one district's process for bringing about change in its elementary and middle school mathematics curriculum and instructional procedures. In addition to possessing the critical elements just noted, the Muhlenberg Mathematics Improvement Project is effective because the district used a well-conceptualized instructional model that teachers could readily apply in their classrooms and followed a step-by-step change process that enabled the participants to see victory at each milestone.□

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