

Synthesis of Research on the Effects of Mastery Learning in Elementary and Secondary Classrooms

The results of well-designed studies show extremely positive student learning outcomes and teacher variables. More studies are needed on several questions, including long-term consequences and effects on classroom interactions and climate.

Programs based on mastery learning concepts are used today at all levels of education from the earliest elementary grades to graduate and professional schools. Although these programs vary widely in their format, they are all tied to a specific theory about the teaching and learning process and an accompanying set of instructional strategies. The theory of mastery learning is based on the simple belief that *all children can learn* when provided with conditions that are appropriate for their learning. The instructional strategies associated with mastery learning are designed to put that belief into practice in modern classrooms.

Current applications of mastery learning are generally based on Bloom's Learning for Mastery model (1968). But the basic tenets of mastery learning were described in the early years of the twentieth century by Washburne (1922) and Morrison

(1926) and can be traced to such early educators as Comenius, Pestalozzi, and Herbart (Bloom 1974).

The increased attention mastery learning has seen in recent years appears to stem from two different sources. First, research studies on the quality of instruction and highly effective schools consistently point to elements of mastery learning as an integral part of successful teaching and learning (Brophy 1979, 1982; Leinhardt and Pally 1982). Second, reports from school systems throughout the United States and around the world indicate that the use of mastery learning strategies can lead to striking improvements in a wide range of student learning outcomes (Block and Burns 1976).

With the increased attention to mastery learning has come some confusion, however. The term "mastery learning" is today applied to a broad range of educational programs and

curriculums, many of which bear little or no resemblance to the ideas described by Bloom and then refined by Block (1971), Block and Anderson (1975), and Guskey (1985a). Further, there is frequent confusion between Bloom's Learning for Mastery model and other forms of individualized instruction.

Bloom's approach to mastery does, of course, share a number of common elements with other forms of individualization. For example, it requires that learning objectives be well defined and appropriately sequenced; it emphasizes that student learning be regularly checked and immediate feedback be given; and it stresses that student learning be evaluated in terms of criterion-referenced, rather than norm-referenced, standards. There are, however, several major differences, particularly in terms of the *basis* and *pace* of instruction prescribed (Block 1974, Block and Burns 1976,

Stice 1979, Swanson and Denton 1977).

The vast majority of individualized instructional programs are *individually based* and *student-paced*. Students generally work at their own pace, independently of their classmates, and move on to new material only after they have demonstrated perfect mastery of each unit. The teacher's role is primarily to give individual assistance when needed rather than to be a principal source of new information. For this reason, carefully designed, self-instructional materials are essential to such a program (Kulik, Kulik, and Cohen 1979, Thompson 1980).

The mastery learning model, on the other hand, is typically a *group-based, teacher-paced* approach to instruction in which students learn, for the most part, in cooperation with their classmates. Mastery learning is designed for use in typical classroom situations where instructional time and curriculum are relatively fixed, and the teacher has charge of 25 or more students. In a mastery learning classroom the pace of the original instruction is determined primarily by the teacher. Support for this idea comes from studies showing that many students, particularly younger students in the elementary grades and those with lower entry-level skills, lack the sophistication and motivation to be effective self-managers of their own learning (Mabee, Niemann, and Lipton 1978, Reiser 1980, Ross and Rakow 1981). Thus the role of the teacher is that of an instructional leader and learning facilitator who directs a variety of group-based instructional methods together with accompanying feedback and corrective procedures.

In 1976, Block and Burns reviewed the results of carefully constructed studies on group-based mastery learning programs. They found that while these programs seldom yielded the large effects on student learning that mastery learning advocates proposed were possible, they did lead to consistently positive effects. In quantitative terms, nearly all programs produced greater student learning than nonmastery approaches, and also produced less variability in that learning. Further, group-based mastery learning programs were found to yield very positive effects on student affective vari-

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ables, such as how students feel about the subject they are studying and how they feel about themselves as learners.

Since the Block and Burns (1976) review, the literature on mastery learning has grown dramatically. Many articles have been written about the mastery learning process, programs have been designed and implemented to use these ideas, and a multitude of studies have assessed the effects of this approach.

The goal of our effort was to review and summarize the results of this now rather large collection of well-designed, outcome-based mastery learning studies. We used meta-analysis techniques (Glass 1976; Glass, McGaw, and Smith 1981) to synthesize the results of these studies in order to answer several major questions about group-based mastery learning programs. Specifically, those questions were: How effective is the typical group-based mastery learning program? What types of educational outcomes are affected by the use of mastery learning? Do programs vary in their effectiveness depending upon the grade level or age of the students involved? Are programs more or less effective depending on the subject matter to which they are applied?

Method

The first step in our research synthesis was to identify and collect studies that examined the effects of group-based

mastery learning programs. The collection began with a computer search of three library data bases: *Dissertation Abstracts*; ERIC (Educational Resources Information Center); and *Psychological Abstracts*. We also manually searched *Mastery Learning: A Comprehensive Bibliography* (Hymel 1982) for studies that might have been missed in the computer search. Since the Block and Burns (1976) review was judged to be a fairly complete summary of the research conducted through 1975, we focused our search on articles and manuscripts that appeared after that year.

These bibliographical searches yielded the titles of over a thousand articles that might have been relevant for our purposes. Based on information about the articles contained in the titles and abstracts, we reduced the initial collection of articles to 234 potentially useful articles that included quantitative analyses or detailed study results. We were able to obtain complete copies of 144 of these articles, manuscripts, and dissertations.

We then read each of these articles and manuscripts in full and evaluated them in terms of several criteria for inclusion in our synthesis. Specifically, we selected only studies that involved applications of mastery learning that were clearly group-based and teacher-paced. That is, we included only studies in which it was evident that students progressed through an instructional sequence as a group and at a pace determined primarily by the teacher. Second, studies had to report data on measured outcomes for students (or teachers) in mastery learning and in control classes, or have a clear time-series design. Third, the studies had to be free from serious methodological flaws.

Most of the articles and manuscripts did not succeed in meeting these criteria. A total of 38 studies did, however, and were included in our final pool of studies. Of these, the 27 that dealt with applications in elementary and secondary classrooms form the basis of this report.

Quantifying Outcomes

The 27 studies included in this synthesis contained findings on program effects in five areas: student achieve-

ment, student learning retention, time variables (including measures of time-on-task and time spent), student affect, and teacher variables. Of course, student achievement was the primary variable of interest in the vast majority of studies.

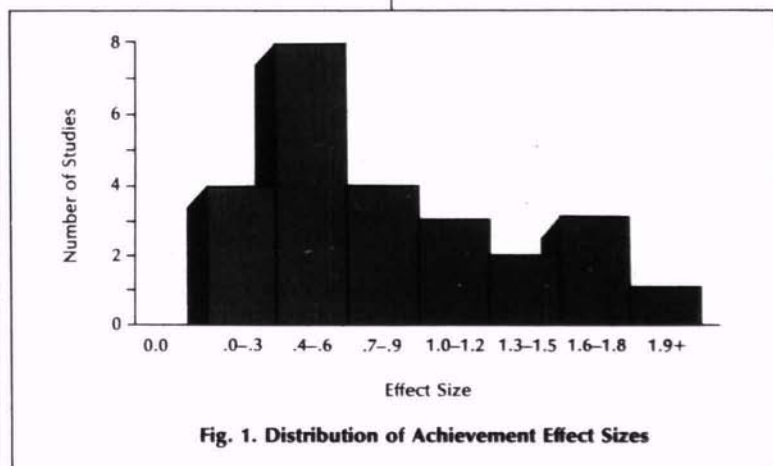
Twenty-five studies reported program results in terms of student achievement outcomes. The most common measure of achievement used in these studies was students' scores on unit or course examinations that were, in most cases, prepared by teachers. Occasionally examinations were prepared by the researchers conducting the investigation and, in a few instances, results from standardized achievement tests were employed. The second most common measure of student achievement was the letter grades attained by students. Generally these were reported as simply distributions of A through F grades in both mastery and control classes, or as class grade point averages.

Three studies measured student learning retention over time. In two studies this was accomplished by re-testing students on the learned materials two to four weeks after instruction on the material had been completed. In the third study, students were re-tested four months after instruction was completed.

Five studies measured time-related variables. The majority of these used measures of student involvement in instruction or time-on-task. However, one study explored differences in the amount of time students actually spent in learning under mastery learning conditions.

Affective outcomes were considered in only one study, which included measures of how much students liked a certain subject and how confident they were of their abilities to learn that subject. Finally, several studies investigated mastery learning's effects on particular teacher variables, such as teachers' expectations for student learning, their attribution assignments, and their attitudes toward the mastery learning process.

To quantify the outcomes of these studies we used the *effect size*, a statistic calculated by taking the difference between the means of the treatment and control groups and dividing that difference by the standard deviation of



the control group (Glass 1976). An effect size equal to +1.0 is considered exceptionally positive for any educational program or innovation. This would mean that the average student in a treatment class achieved at a level attained by only the top 15 percent of students in a comparable control class. The effect size statistic provided us with a useful metric for comparing the results from different studies and de-

termining the overall magnitude of the effect of mastery learning (Glass, McGaw, and Smith 1981; Hedges and Olkin 1985).

Student Achievement

The results of our synthesis of studies involving measures of student achievement are illustrated in figure 1. All of the 25 elementary and secondary school studies reporting achievement outcomes showed positive effects as a result of the application of group-based mastery learning strategies. In other words, in no study did students under control conditions perform better than those under mastery conditions. However, the size of the effect varied considerably from study to study. The achievement effect size for these studies ranged from .02 (Slavin and Karweit 1984) to greater than 1.70 (Arlin and Webster 1983, Burrows and Okey 1975). In fact, the distribution of effect sizes was so diverse that we considered it inappropriate to calculate a measure of central tendency describing the "typical" effect size from the application of group-based mastery learning strategies.

To explore possible explanations for this tremendous variation in effect size, we grouped the studies along two dimensions and calculated pooled effects within these groupings. Studies were grouped first by student grade level and second by the subject area to which the mastery learning strategies had been applied.

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Table 1. Effect Size by Grade Level

Level	Grades	No. of Studies	Mean Effect Size
Elementary	1-6	5	.89
Junior High	7-8	8	.93
High School	9-12	12	.72

The results of grouping the studies by grade level are shown in Table 1. These results indicate that although the effects of group-based mastery learning strategies are positive across all levels of education, they appear to be larger for younger students in elementary and junior high school classrooms than for older high school students. The average effect size for studies involving elementary students was .89. Studies involving junior high school students had a very similar average effect size of .93, while those involving high school students had an average of .72.

One possible explanation for these differences across grade levels relates to the theoretical premises of mastery learning. In outlining the theory of mastery learning, Bloom (1976) emphasized that students' *cognitive entry behaviors* bear a very strong influence upon their learning. That is, the academic preparation and learning history students bring with them to a teaching and learning situation can have a powerful effect on their level of achievement. This history determines the cognitive skills and abilities students bring to the classroom. It also influences how they feel about learning and about themselves as learners. Elementary school students enter classrooms with a learning history that is much less extensive than that of high school students. Hence the potential of mastery learning, or any strategy designed to improve students' level of achievement, is theoretically far greater in the elementary grades where acquired learning deficiencies are likely to be easier to overcome.

Another possible explanation is that curriculum differences across grade levels have some influence on the effectiveness of mastery learning strategies. At the elementary level there is

generally strong continuity among instructional units and learning is highly sequential. New units typically build on the skills or learning objectives taught in previous units or in earlier grades. Hence, the effects of mastery learning undoubtedly carry over from unit to unit, year to year, and are likely to be cumulative. At the high school level, on the other hand, courses and even units within courses tend to be less ordered, less sequential, and hence are less likely to be influenced by cumulative learning patterns.

The results of grouping the studies by subject area are shown in Table 2. Studies grouped under science include classes in general science, biology, and chemistry. Mathematics studies include basic math, general math, consumer math, algebra, matrix algebra, fractions, geometry, and graphs. Those studies grouped under social studies include government, history, and general social studies. Classes involving English, grammar, reading, vocabulary, and foreign language were grouped under language arts. Since several studies investigated the application of mastery learning in a number of different subject areas, the total number of studies indicated in this table is larger than that shown in Table 1.

These results again illustrate the positive effects of mastery learning strategies in all subject areas. Nevertheless, there do appear to be subject area differences. Applications involving science and mathematics produced average effect sizes of .78 and .81, respectively, both of which are very positive. However, applications to instruction in social studies and language arts yielded even more positive effect sizes of .91 and .99, respectively.

These findings are not altogether what mastery learning theorists typically predict. Bloom (1976) and Block (1971) both suggest that while mastery learning procedures are likely to enhance learning outcomes in most all subject areas, effects will probably be largest in mathematics and science. After all, learning in these subject areas is generally more highly ordered and sequential. An instructional process based upon having students attain a high learning standard in each unit of an instructional sequence would thus seem particularly promising in these subjects.

It may be, however, that the ordered and sequential nature of learning in mathematics and science is generally recognized by teachers. As a result, instruction in these subjects may already more frequently incorporate elements of the mastery learning process. Instruction in social studies and language arts, on the other hand, is generally less clearly ordered and sequential. Learning objectives in these subjects are usually less well defined, the best or most appropriate sequence of objectives is less clear, and procedures for evaluating students' learning are typically more subjective. Therefore, to incorporate mastery learning into instruction in social studies and

Table 2. Effect Size by Subject Area

Subject Area	No. of Studies	Mean Effect Size
Science	7	.78
Mathematics	16	.81
Social Studies	4	.91
Language Arts	5	.99

language arts probably requires greater effort and greater change in instructional procedures. But at the same time, the evidence indicates that these changes typically result in very positive effects on student learning.

Student Retention

We found three studies that investigated students' retention of learned material over time. Block (1972) measured 8th grade students' retention of the material from a brief unit on matrix algebra two weeks after they had completed the unit. The effect size favoring students taught under mastery conditions was found to be .62. In a study by Wentling (1973), high school students were retested on their knowledge of material they had learned three weeks earlier in a course in automobile mechanics. Again, mastery-taught students performed far better on the retention test, the effect size being .51. We found one study that investigated long-term retention (Anderson, Scott, and Hutlock 1976). Elementary students in this study were retested on their retention of the material four months after completing instruction. The retention of mastery students was again found to be significantly greater, with an effect size of .52.

The results of these studies show that group-based mastery learning strategies do appear to have a positive effect on student learning retention, although not quite as large an effect as upon initial levels of achievement. Clearly, however, additional well-designed studies measuring long-term retention over a period of months or a year are definitely needed.

Time Variables

Several mastery learning studies investigated variables related to time. The variable most frequently considered was academic engaged time or *time-on-task*. The four studies that included data on time-on-task all gathered these data through similar techniques involving classroom observations of students. Comparisons between mastery and nonmastery classes yielded a positive average effect size across the four studies of .68.

Another time-related variable that has received increased attention in recent mastery learning studies is *time spent*. Interest in this variable stems

from early writings on mastery learning and specifically Bloom's (1971) notion that under more appropriate instructional conditions, students become more similar in their level of achievement and in their learning rate. That is, the differences in the time the fastest and slowest learners need to learn certain content to a specified criterion begin to diminish. Bloom further suggested that mastery learning might be one way to offer the vast majority of students more appropriate instructional conditions. He believed that through procedures such as those offered by mastery learning, students' learning rates could be altered and slow learners could be helped to learn faster. Two studies by Anderson (1975a, 1976) offered evidence supporting Bloom's notion.

In several recent studies and reviews, however, Arlin (1982, 1984a, 1984b) argues that learning rate is a fairly stable and unalterable student characteristic. He suggests that the positive gains evidenced in most mastery learning programs come mainly from continually providing greater amounts of learning time for students who are experiencing problems or difficulties. Since this time must come from somewhere, Arlin argues that learning in other areas or other subjects must be sacrificed to gain these results.

But the findings from one of Arlin's own studies actually lend support to Bloom's original notion. In this study, Arlin (1984a) followed the progress of elementary students in mastery learning classes over ten instructional units. Analyses of the data on remedial time in each unit showed that the amount of time needed to bring students to a mastery criterion dramatically *decreased* over instructional units. Although this statistically significant linear reduction in remedial time was identified by Arlin, it was largely ignored.

This evidence from Arlin's study, along with that presented in Anderson's (1975a, 1976) studies, suggests that differences between fast and slow learners do decrease under mastery learning. That is, learning rate does appear to be alterable, and mastery learning procedures may be one way slow learners can be helped to increase their learning rate.

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Evidence on ways to accommodate initial differences in students' learning rates is less definite, however. Clearly the introduction of mastery learning compels many, and perhaps most, students to spend additional time on learning activities. But it is less clear whether this time must come from that previously allocated to learning in other subject areas, as suggested by Arlin (1984b) and Slavin and Karweit (1984), or whether it can be gained by encouraging students to spend a greater portion of their school time actively engaged in learning, as suggested by Block (1983) and Guskey (1983). Evidence supporting the latter of these two perspectives was provided in a recent study by Fitzpatrick (1985), which demonstrated that under mastery learning, time for instruction is used more purposefully by both teachers and students, the time spent in transitions between instructional events and in nonacademic interactions is decreased, and the rate of student off-task behavior is dramatically reduced. Additional supporting evidence also comes from a recent study by Tennyson, Park, and Christensen (1985). Still, further studies that include systematic procedures for gathering data on time allocations and learning rates are needed.

Student Affect

Systematic measures of student affective variables were included in only one of the elementary school studies

that we considered. Anderson, Scott, and Hutlock's (1976) investigation included measures of students' attitude toward the subject they are studying and their academic self-concept. Their results indicate that mastery learning procedures have a positive effect on these outcomes, although not as large as the effect on cognitive outcomes. Students who learned under mastery conditions generally liked the subject they were studying more and were more confident of their abilities in it, the effect sizes being .41 and .49, respectively.

Teacher Variables

A final area investigated in several mastery learning studies is its effects upon teachers. In general, the four studies we located focused on how teachers react when they begin using mastery learning and, as a result, see more of their students learning well and attaining higher levels of achievement. In an early study in this area, Okey (1977) found that teachers and teaching interns expressed much more positive attitudes toward the philosophy and practices of mastery learning after they had used these practices in their elementary classrooms for only three weeks. The effect size for this attitude change was 1.67.

More recently, Guskey (1982) found that teachers who successfully implement mastery learning begin to alter their expectations for students' achievement and find it much more difficult to predict which students will do well and which students will experience learning difficulties. Generally, teachers form expectations about students' abilities during the first couple of weeks of the school year, and these expectations are highly related to students' final achievement. But in this study, that relation was found to approach zero for teachers implementing mastery learning, apparently because many students made far greater progress than originally anticipated and because the teachers were effective with many more of their students. In another study, Guskey (1985b) discovered that after using mastery learning, teachers also alter their explanations as to why they are effective in the classroom, giving less importance to personality factors (effect size = -.38) and far greater importance to teaching

Highlights of Research on Group-Based Mastery Learning Programs

A meta-analysis of 27 well-designed studies shows that:

- Achievement results are overwhelmingly positive, but vary greatly from study to study.
- Although students at all levels appear to benefit from mastery learning, effects are somewhat larger in elementary and junior high school classes than at the high school level.
- Although applicable across subject areas, effects in language arts and social studies classes are slightly larger than those attained in science and mathematics classes.
- Students tend to retain what they have learned longer under mastery learning, both in short-term (2-3 weeks) and long-term (4 months) studies.
- Students are engaged in learning for a larger portion of the time they spend in mastery classes and require decreasing amounts of remedial (corrective) time over a series of instructional units.
- Students in mastery classes develop more positive attitudes about learning and about their ability to learn.
- Teachers using mastery learning develop more positive attitudes toward teaching, higher expectations for students, and greater personal responsibility for learning outcomes, but may experience diminished confidence in their teaching skills.

practices and behaviors (effect size = 1.13).

Finally, in a large-scale study involving 117 junior and senior high school teachers, Guskey (1984) found that teachers who use mastery learning and see improvement in student learning outcomes begin to feel much better about teaching and their roles as teachers (effect size = .61), accept far greater personal responsibility for their students' learning successes and failures (effect size = 1.25), but express somewhat less confidence in their teaching abilities (effect size = -.59). This seemingly anomalous finding was explained by Guskey as a "humbling effect." That is, to suddenly gain evidence that they could be far more effective in their teaching caused these teachers to reconsider their confidence that they were already doing the best that was possible. No attempt was made to follow up these teachers, however, to determine whether this "humbling effect" endured or diminished over time.

It thus appears that the successful use of mastery learning can have powerful effects on many teacher variables. Caution must be taken in interpreting these effects, however, because not all are positive. In addition, because no extended follow-up studies or long-term investigations have been conducted, we have no evidence as to

whether these effects endure or whether they are a temporary condition resulting from the initial novelty of a new approach.

Discussion

This synthesis of research on elementary and secondary school group-based mastery learning programs supports the findings of other reviews of the effectiveness of mastery learning. Like Block and Burns (1976) and more recently Walberg (1984), we found that group-based applications of mastery learning have consistently positive effects on a broad range of student learning outcomes, including student achievement, retention of learned material, involvement in learning activities, and student affect. In addition, we found that the use of mastery learning has significant effects on several teacher variables, although these effects are mixed. Our synthesis also revealed, however, that the magnitude of the effect on student achievement measures varies widely across studies and, hence, calculation of an average effect size was considered inappropriate.

Many factors undoubtedly contribute to this variation in student achievement effects. Several of these were explored here, including the grade level of the students and the subject area to which mastery learning strategies were applied, but other less mea-

surable factors may have influenced the results as well. For example, all of the studies included in our synthesis were conducted in actual classroom settings. The major advantage of this is that it offers a more accurate estimate of the effects of mastery learning in this type of setting than is possible from studies conducted in more artificial settings, such as learning laboratories. The major disadvantage, however, is that studies conducted in classroom settings are subject to the many extraneous influences present in those classrooms. Differences in student characteristics, teacher characteristics, student-teacher interactions, and classroom environments may all influence study results. These influences are extremely difficult to measure or control and may explain, at least partially, the large variation in study results.

Another factor that undoubtedly contributes to the variation in magnitude of the effects is the lack of precision in specifying the treatment. As mentioned earlier, there is confusion and debate as to what is, and what is not, mastery learning. This confusion involves not only the basis and pace of the instructional format, but also the essential characteristics of the feedback students are offered, the essential characteristics of the corrective activities in which they are involved, and the specific procedures used to evaluate their learning. Many of the studies in this synthesis did not include detailed descriptions of the mastery treatment (or the nonmastery control), and those that did served mainly to illustrate how widely varied that treatment can be. In addition, few studies provided details on the quality or extent of the teacher training that might have been involved.

While this synthesis shows clearly that the effects of group-based applications of mastery learning are overwhelmingly positive, many questions remain. For example, we need to know much more about the long-term effects of mastery learning. Bloom (1976) theorized that students who learn a subject under mastery learning conditions are more likely to develop the cognitive entry behaviors necessary for more advanced study in that subject, so they are more likely to do well in later grades or in higher level

courses, even when the mastery learning procedures are not continued. A small-scale exploratory study by Bonczar, Easton, and Guskey (1982) supports this notion. Still, more detailed, longitudinal studies that follow students over several years, particularly through continued applications of mastery learning procedures, are definitely needed.

We also need to know more about the degree to which students who learn under mastery learning conditions develop "learning-to-learn" skills. These are skills that students can use on their own to enhance their effectiveness and efficiency in learning situations, regardless of the teacher or the instructional format. Clearly, group-based mastery learning procedures help students better organize their learning, use teacher feedback, pace their learning, and work at correcting their learning errors. But at present we do not know whether students who experience mastery learning in one subject are able to carry over these skills to learning in other subjects or to other classes. Nor do we know the particular conditions that foster skills transfer. The development of such learning-to-learn skills would seem one of the most powerful benefits of mastery learning strategies and one that we need to better understand.

Similarly, we need further studies on practical and efficient ways of providing fast learners in group-based mastery learning classrooms with opportunities to extend their learning through rewarding and challenging enrichment activities. We need to know more about the benefits and costs of such activities and how they can be best used to offer these students valuable learning experiences that may not be generally available in classes taught by methods or techniques other than mastery learning.

Finally, we need to know more about how the use of mastery learning might alter classroom climate, teacher-student interactions, and student-student interactions. Block and Anderson (1975) and Guskey (1985a) note that teachers using mastery learning are likely to find that their role in the classroom changes from that of a judge who evaluates and categorizes students by class rank, to that of a learning leader who works to make all

students successful learners. However, this change, or its implications, has not been systematically explored. It has also been noted that students in mastery learning classrooms readily cooperate with one another and that peer tutoring frequently occurs spontaneously. Mevarech (1985) and Slavin and Karweit (1984) demonstrated that cooperative learning strategies and student teaming can be easily facilitated in mastery learning classrooms. Still, additional studies investigating the effects of mastery learning on these interpersonal dimensions of the classroom environment are greatly needed.

In summary, this synthesis provided us with some valuable insights into the effectiveness of group-based mastery learning programs and illustrated some of the advantages of meta-analytic procedures. It did not, however, provide us with definitive answers.

Group-based mastery learning strategies clearly show great potential and great promise. It appears they can be implemented in regular classrooms without major revisions in instructional procedures, class organization, or school policy. At the same time, the research evidence reviewed here indicates that the use of these strategies can result in significant improvements in a broad range of student learning outcomes and teacher variables. □

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Thomas R. Guskey is associate professor, Educational and Counseling Psychology, and **Sally L. Gates** is a doctoral student in educational psychology, College of Education, University of Kentucky, 251 Dickey Hall, Lexington, KY 40506-0017.

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