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Mastery Learning

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Mastery learning is a philosophically based approach to the design of classroom environments that is currently creating controversy in the educational research and development community. Critics of mastery learning assert that mastery approaches to instruction are rigid, mechanistic, training strategies (Groff, 1974; Jaynes, 1975); that they can only give students the simple skills required to survive in a closed society (Cronbach, 1972); and that they do not appreciate the complexities of school learning (L. S. Bowen, 1975). Adherents of mastery approaches to instruction maintain that they are flexible, humanistic, educational strategies (Levin, 1974; Scriven, 1975); that they can provide students with the complex skills needed to prosper in an increasingly open society (H. M. Levin, 1975); and that they do take into account the realities of classroom life (Block & Anderson, 1975).

In this chapter we propose to introduce the basic ideas and practices that have generated this controversy, as well as to review the associated research. We begin the chapter with a broad overview of mastery learning philosophy, theory, and practice. We then take a relatively microscopic view of four types or classes of research generated by these ideas and practices. In the final section we take a more macroscopic view of this research and ask what our findings may mean in practical, theoretical, and ideological terms.

NATHANIEL L. GAGE, Stanford University, and PENELOPE L. PETERSON, University of Wisconsin, Madison, were the editorial consultants for this chapter.

Trying to write a balanced chapter on so controversial a topic is hard enough, but it is even harder when one of the writers has been identified as a mastery learning advocate. We are indebted to our editorial consultants, and to our colleagues, P. W. Airasian, L. W. Anderson, R. M. Elmore, J. A. Kulik, S. W. Nicholson, and M. Phillips for their many helpful comments and objective criticisms.

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AN OVERVIEW

Underlying mastery learning theory and practice is an explicit philosophy about learning and teaching (see Anderson & Block, 1976; Block & Anderson, 1975, for details). Essentially this philosophy asserts that under appropriate instructional conditions virtually all students can learn well, that is, can "master," most of what they are taught. Moreover, it proposes that teachers can teach so that all students *do* learn well. Such teaching for mastery, it is argued, should increase students' chances for both short-term and long-term social survival. They should be able to acquire some basic intellectual competencies which will help ensure that they *can* undertake the subsequent learning demanded of them by their schools and eventually their vocations and avocations. Moreover, they should be able to acquire some positive feelings toward learning, based on these acquired competencies, that will help ensure that they *want* to undertake this subsequent learning. Teaching for mastery should also increase teachers' chances for vocational survival. Teachers could thereby acquire some meaningful career rewards, perhaps the most powerful of which is the experience that their teaching consistently pays off in high levels of learning for most of their students, rather than just a few.

Particular elements of this philosophy are obviously not new to Western educational thinking. Bloom (1974), for example, found the idea that all can learn and learn well in the writings of early educators such as Comenius, Pestalozzi, and Herbart and of contemporary figures such as Washburne and Morrison; Cronbach (1972) found the same idea reflected in the writings of the English Enlightenment philosopher John Locke. However, the philosophy has again been pushed toward center stage in current educational thought by the spread of two individualized instructional strategies which have attempted to put it into practice. One of these strategies has evolved from the field of education and has had its major impact on the thinking of elementary and secondary school educators—Bloom's (1968) Learning for Mastery (LFM). The other has evolved from the field of psychology and has had its major impact on the thinking of university and college educators—Keller's (1968) Personalized System of Instruction (PSI).

The Learning for Mastery Strategy

Learning for Mastery (LFM) is a group-based, teacher-paced approach to mastery instruction wherein students learn, for the most part, cooperatively with their classmates. It is designed for use in situations where the instructional time available to students in a particular subject is relatively fixed and restricted. However, it can easily be adapted to an individually based, student-paced approach for use in situations where the instructional time is more fluid and unrestricted.

The theoretical basis for the strategy was provided by a conceptual model of school learning developed by John B. Carroll (1963, 1965). In this model, student aptitude for a given subject was viewed as an index of the *amount of time* the student would require to learn the subject *to a given level,* rather than as an index of the *level* to which a student could learn the subject *in a given amount of time.* Simply put, Carroll's model proposed that if each student was allowed the time he needed to learn the subject to some criterion level, and if he spent the necessary time to do this, then he would probably attain that level.[1] However, if the pupil were not allowed enough time or did not spend the required time, then the degree to which he would learn could be expressed as follows:

$$\text{Degree of school learning} = f\left(\frac{\text{Time spent}}{\text{Time needed}}\right)$$

Thus the degree of school learning would be a function of the time the student actually spent in learning relative to the time he needed to spend. Subsequent work by Carroll (1973) and others (e.g., Sjögren, 1967) suggested that this function was essentially linear.

Carroll believed that in the school situation the "time spent" and the "time needed" were influenced not only by characteristics of the learner but also by characteristics of his instruction. To be specific, he believed the time spent was determined by the student's *perseverance,* his *opportunity to learn,* or the *time he needed to learn,* where the student's perseverance was defined as the amount of time the student was willing to spend actively engaged in learning, opportunity to learn was defined as the classroom time allotted to learning, and time needed to learn was defined as described below. It was Carroll's belief that if both the student's opportunity to learn and his time needed to learn were greater than his perseverance, then his perseverance would determine the time spent in learning. Likewise, if both his perseverance and his time needed were greater than his opportunity, then his opportunity would determine the time spent. And if both his perseverance and his opportunity were greater than his time needed, then the time needed would determine the time spent: The student would spend no more time in learning than he needed to spend.

The time needed, on the other hand, was determined by the student's *aptitude* for the subject, the *quality of his instruction,* and his *ability to understand this instruction.* As mentioned above, Carroll conceived of the student's aptitude for the subject as determining the time he would require to learn the subject matter under ideal instructional conditions. The quality of the student's instruction and his ability to understand that instruction were conceived as interactively determining the additional time he would require to learn the

[1] We are well aware of the sexism implicit within the English language. But as a stylistic convention, we shall use masculine terms to refer to teachers and students throughout the chapter.

subject under less than ideal conditions. If the quality of instruction were high, then the student would readily understand it and would need little additional learning time over and above the time demanded by his aptitude. But if the quality of instruction were low, then the student would have difficulty understanding it and would need much additional learning time.

The complete Carroll model of school learning can be represented, therefore, as follows:

$$\text{Degree of school learning} = f\left(\frac{\text{Time spent}}{\text{Time needed}}\right)$$

$$= f\left(\frac{\text{Time willing to spend or Time allowed}}{\text{Time required (subject matter)} + \text{Time required (instruction)}}\right)$$

$$= f\left(\frac{\text{Perseverance or Opportunity to learn}}{\text{Aptitude} + [\text{Quality of instruction} \times \text{Ability to understand instruction}]}\right)$$

In brief, *the degree of school learning of a given subject depended on the student's perseverance or his opportunity to learn, relative to his aptitude for the subject, the quality of his instruction, and his ability to understand this instruction.*

Benjamin Bloom (1968) transformed this conceptual model of school learning into a working model for mastery learning by the following logic. If aptitude were predictive of the time a student would require to learn, but not necessarily the level to which he could learn, it should be possible to fix the degree of school learning expected of each student at some criterion level of mastery performance. Then, by attending to the variables under teacher control in Carroll's model—the "opportunity to learn" and the "quality of instruction"—the teacher should be able to ensure that each student attained this level.

Elaborating on this logic, Bloom argued that if students were normally distributed with respect to aptitude for a certain subject and were provided with *uniform* opportunity to learn and *uniform* quality of instruction, then few students could be expected to attain mastery, and the correlation between aptitude and achievement in the subject would be high ($r = +.70$). But if each student received *differential* opportunity to learn and *differential* quality of instruction, then a majority of students, perhaps as many as 95%, could be expected to attain mastery, and the correlation between aptitude and achievement in the subject would approach zero. In other words, individual differences in students' aptitude for the subject would have little bearing on their final achievement.

In accordance with this logic, Bloom next sketched the outline for the original LFM strategy. Some of the basic features of this outline have been summarized by McNeil (1969, p. 308).

1. The learner must understand the nature of the task he is to learn and the procedure he is to follow in learning it.
2. Formulation of specific instructional objectives for the learning task is important. . . .
3. It is useful to break a course or subject into small units of learning and to test at the end of each unit.
4. The teacher should provide feedback on the learner's particular errors and difficulties after each test.
5. The teacher must find ways to alter the time some individuals need to learn.
6. It may be profitable to provide alternative learning opportunities.
7. Student effort is increased when small groups of two or three students meet regularly for as long as an hour to review their test results and to help one another overcome the difficulties identified by means of the test.

Block (1971, 1973a) and, more recently, Block and Anderson (1975) have refined and elaborated upon this outline so as to make Bloom's ideas more systematic and practical. The strategy that has resulted can be described as follows. (See Block & Anderson, 1975, for details.)

Defining Mastery. The teacher who wishes to use an LFM approach begins by formulating what he means by "mastery" of his subject. First, he defines what all students will be expected to learn by formulating a set of course instructional objectives. Second, he prepares a final or "summative" examination (Bloom, Hastings, & Madaus, 1971) over these objectives and determines what level or course mastery performance standard all students will be expected to achieve on this examination. The level is typically that which A-level students have achieved when the subject has been taught by traditional, nonmastery methods. Third, the teacher breaks the whole course into a sequence of smaller learning units, each covering about two weeks' worth of material. Fourth, he determines the course objectives to be covered in each unit.

Planning for Mastery. The teacher now plans instructional procedures to help each student master the course objectives in each unit. First, he plans how he will initially present each unit's material and involve students in its learning. He is encouraged to plan on using his customary group-based teaching methods.

Second, he develops "feedback/correction" procedures to be used at the close of each unit's initial instruction. He constructs a brief, diagnostic-progress or "formative" test (Bloom et al., 1971) over the unit's objectives. This test will provide information on how each student's learning is changing as a result of the unit's initial instruction. He also specifies a score or performance standard on this test, typically 80 to 90% correct, which, when met, will be indicative of unit mastery.

Third, he develops a set of alternative instructional materials and procedures or "correctives" keyed to each item on the unit's formative test. These correctives are designed to reteach the material tested by each item, but in ways that differ from the unit's initial instruction. They typically consist of small-group study sessions, individual tutoring, or alternative learning aids such as different textbooks, workbooks, and audiovisual materials. Hence if a student should encounter difficulty in learning certain material and his formative test performance is below the unit mastery standard, he will be able to explore alternative ways of learning the unmastered material and to select those best suited to his individual requirements.

Teaching for Mastery. The teacher is now ready to teach. Since students are not accustomed to learning for mastery or the notion that they all might earn A's, the teacher spends some time at the outset orienting his students as to what they are expected to learn, how they are generally expected to learn it, and to what level they are expected to learn.

Following this orientation period, the teacher teaches the first learning unit, using his planned initial teaching methods. When this instruction has been completed, and before moving to the next unit, he administers the unit's formative test. Using the test results, he certifies those students who have achieved the unit mastery standard and identifies those who have not. The former students are free to engage in enrichment activities and/or to serve as tutors for their "slower" classmates; the latter are asked to use the appropriate correctives to complete their unit learning.

The teacher then announces when the initial instruction for the next unit will commence, and both sets of students are given responsibility for making use of the opportunities provided. If the teacher desires to postpone the start of the next unit, the students are given in-class as well as out-of-class time to discharge their respective responsibilities. If he does not do so, then they must use out-of-class time.

The teacher repeats this cycle of initial instruction, diagnostic-progress testing, and certification or individual correction, unit by unit, until all units have been taught. He paces the cycle so that he covers just as much material as he would ordinarily cover with traditional methods in the calendar time he has available for instruction. This helps ensure that all students, the "faster" as well as the "slower," are exposed to as much course material as they would ordinarily encounter.

The teacher has two pacing options. If all the student enrichment/tutoring or correction responsibilities are to be discharged outside of class, then he may pace his instruction as usual. However, if some or all responsibilities are to be discharged in class, the teacher can adjust the pace of his instruction, allowing more time for the early units and less time for the later ones. Essentially, he borrows time that would ordinarily be spent on later units and spends this time on the earlier units. The assumption is that the additional time spent early will be made up later; students who learn for mastery at the outset of a course should learn more effectively and efficiently than usual as the course proceeds.

Grading for Mastery. The teacher finally administers the course final or summative examination and awards A's or their equivalent to all students whose test scores are above the course mastery performance level. Those students who score below this level are awarded grades appropriate to the level they have achieved. This grading procedure places each student in competition with himself and the material to be learned for an A grade, rather than in competition with his classmates.

Personalized System of Instruction

The Personalized System of Instruction (PSI) is an individually based, student-paced approach to mastery instruction wherein students typically learn independently of their classmates. It is designed for use in situations where the time available to students for instruction in a given subject is relatively fluid and unrestricted.

The theoretical basis for this strategy lay in B. F. Skinner's pioneering work in operant conditioning and the application of that work in the programmed instruction movement of the 1960s. Some of the basic features of this movement have been summarized by Hartley (1974, p. 279).

1. The learner should be given some clear idea of where he is going, i.e., the terminal behavior.
2. The instruction leading to this behavior must be sequenced into small steps.
3. The learner should work on each step alone and at his own pace.
4. At each step, the learner should be encouraged to actively respond.
5. The learner should receive immediate knowledge of results concerning the correctness or appropriateness of these responses.

The programmed instruction movement encountered some real problems, however, in implementing these features in the classroom. The features were geared for teaching individual learners, not groups of learners. Further, some of them (e.g., the small steps) did not correspond to the way subject matter was classroom taught (e.g., large steps). And, most important, the features tended to ignore the personal-social element in classroom learning.

So it was not until the work of Fred S. Keller and his colleagues (Azzi, Bori, and Sherman) in the middle sixties that classical programmed instruction ideas were effectively modified for classroom use. First, Keller and associates attempted to gear the ideas to the teaching of whole classes. Second, they expanded the size of the steps to be taught for mastery and made these steps more school like. The steps became learning units which corresponded to about one week's worth of instruction. Finally, Keller and his colleagues added a personal-social aspect to their instructional program. Humans (student proctors) were to be used to provide immediate feedback to learners regarding the adequacy or inadequacy of their learning.

The result of these modifications was the novel approach to programmed instruction which is now called PSI. The essential features of PSI approaches have been nicely summarized by Keller (1968, p. 7) as follows:

1. The go-at-your-own-pace feature, which permits a student to move through the course at a speed commensurate with his ability and other demands upon his time.
2. The unit-perfection requirement for advancement, which lets the student go ahead to new material only after demonstrating mastery of that which preceded it.
3. The use of lectures and demonstrations as vehicles of motivation rather than sources of critical information.
4. The stress upon the written word in teacher-student communications.
5. The use of proctors, which permits repeated testing, immediate scoring, almost unavoidable tutoring, and a marked enhancement of the personal-social aspect of the educational process.

Sherman (1974) has called attention to a sixth feature of PSI strategies:

6. No penalties for errors in learning.

Keller and Sherman (1974) have recently described explicit procedures for implementing these features. The strategy they detail is summarized in the following sections.

Defining Mastery. The instructor who wishes to use a PSI approach begins by subdividing his whole course into a series of teaching-learning units. Each unit typically covers about a week's worth of material. Then the instructor determines the course objectives to be mastered in each unit. Next he decides on his course grading policy, particularly whether or not he will give a final exam or supplemental work. If he decides not to give a final, each student's grade will be determined by his cumulative unit performance; that is, a certain number of units mastered earns an A. However, if the instructor decides to give a final exam or supplemental work, then a small part (usually 25%) of each student's grade will be determined by his performance on this material. The major part (usually 75%) will still be determined by his cumulative unit performance. Either way, the student's final grade will be based on his actual accomplishments rather than on his effort.

Planning for Mastery. The instructor then develops materials for teaching each unit. First, he develops a written study guide through which all students can be initially exposed to the unit's material. Typically, this guide will consist of an introduction, a statement of objectives, study questions, and suggested study procedures. The study procedures and questions are keyed primarily to the course textbook or books.

Second, he prepares simple feedback/correction procedures for each unit. A set of parallel-form tests over the unit's objectives is developed. Most strategies use a combination of multiple-choice and short written answer exams, while a few use oral, performance, or oral and written exams. These tests will provide information to the student and his proctor about how the student's learning is progressing as a result of completion of the unit's study guide. Moreover, they will provide the opportunity for repeated testing of the student should his initial unit learning be below the mastery level. Once these tests are constructed, the instructor sets a unit mastery performance standard which students will be expected to achieve on at least one of the forms (usually 90% or more correct). Finally, he prepares a set of proctor materials which outline how to administer and score the unit tests and which suggest procedures for correcting the learning problems of those students whose unit test performance is below mastery level. These procedures provide the student with more practice of the unmastered material in the unit study guide. Typically, they entail restudy or proctorial tutoring over particular portions of the guide.

Third, the instructor develops a written course policy statement. This statement will serve to orient students as to how they are expected to learn the course material and to what level they are expected to learn it.

Teaching for Mastery. The instruction can now begin. On the first day of class the instructor hands out the course policy statement and may also give a brief account of the basic features of PSI and the benefits students can expect from this method of teaching. Each student is then free to proceed through the teaching-learning units at his own pace, until he has mastered enough units to earn an A or until the instructional time expires.

The student begins his study of the first unit by following the procedures outlined in the unit's study guide. At the completion of his initial attempt to learn the unit's material, he approaches his "proctor" and is given one of the unit mastery tests. This proctor may be an advanced student or a classmate. Upon completion of this form, the student turns it in to the proctor for immediate correction.

If his performance is judged to be at or above the unit mastery standard, he is commended by the proctor and passes on to the next unit. If not, he is required to use the unit's correctives to restudy the unmastered material before returning for retesting. After completing this review, the student returns to the proctor for another form of the unit test. If his test performance is now up to the standard, he is commended and passed on to the next unit. If not, he continues to restudy. This testing, restudy, retesting cycle continues until the student demonstrates mastery on one form of the unit's test. He too then passes on to the next unit.

Grading for Mastery. Finally, the student is given the final examination, if any. He is graded according to the preset course-grading policy. Thus his grade depends solely on his own accomplishments, rather than on the accomplishments of his classmates.

THE MASTERY LEARNING RESEARCH

It should be clear from the overview above that the origins of the LFM and PSI approaches to mastery instruction are different. The former has evolved from a model of *school learning;* the latter, from a theory of *learning* as applied to schools. Yet the approaches are remarkably similar in their general ideas about instruction.

Like other individualized instructional strategies, such as IPI, IGE, and PLAN (see Talmage, 1975), the LFM and PSI approaches assume that virtually all students can master a great deal of what they are taught in school if the "instruction is approached systematically, if students are helped when and where they have learning difficulties, if they are given sufficient time to achieve mastery, and if there is some clear criterion of what constitutes mastery" (Bloom, 1974, p. 6). Consequently, both LFM and PSI do the following:

1. They prespecify a set of course objectives that students will be expected to master at some high level.
2. They break the course into a number of smaller learning units so as to teach only a few of the course's objectives at one time.
3. They teach each unit for mastery—all students are first exposed to a unit's material in a standard fashion; then they are tested for their mastery of the unit's objectives, and those whose test performance is below mastery are provided with additional instruction.
4. They evaluate each student's mastery over the course as a whole, on the basis of what the student has and has not achieved rather than on how well he has achieved relative to his classmates.

Unlike other individualized instructional approaches, however, LFM and PSI mastery approaches are designed for use in the typical classroom situation where the teacher already possesses a curriculum which he must get through in a fixed period of calendar time, where inordinate amounts of instructional time cannot be spent in diagnostic-progress testing, and where student learning must be graded. Further, at least one of these mastery approaches (i.e., LFM) can be implemented in either a group-based, teacher-paced format or an individual based, self-paced format. Lastly, both approaches rely primarily on human beings (teachers and students) for their success rather than on computers, technological devices, and so on. Teachers are free to decide what goes on in the classroom (i.e., to set their own instructional objectives) and to use instructional techniques and materials they may already possess. And students are given some measure of responsibility for their learning (e.g., the selection and use of correctives), as well as an opportunity to teach each other.

A large amount of research has been generated by these general ideas about instruction. Our first step in gathering this research was to locate studies in which a teaching strategy that was claimed to be a LFM or PSI strategy was implemented. For this purpose we turned to published research in professional books and journals, to accessible unpublished or soon-to-be-published papers from professional research meetings, and to accessible unpublished doctoral dissertations.[2] We had two reasons for not relying solely on published research. Wc felt that the unpublished research might help us to better capture the sweep and dynamism of the mastery learning field. We also felt that the unpublished might provide more articles where mastery learning strategies may have failed to work. Books and journals tend to avoid publishing such articles; yet, as Scriven (1975) has suggested, sometimes a breakdown with a particular treatment is more informative than a breakthrough.

Our next step was to sift through these papers to identify the research tradition from which each derived. The reviews by Kulik (1975), Kulik, Kulik, and Carmichael (1974), Ruskin (1974) and Ryan (1974) served to identify the major studies from the PSI tradition. Our own reviews (Block, 1971, 1974) and judgment served to identify the major studies from the LFM tradition.

Finally, besides some particular methodological criteria (to be mentioned as we proceed), we applied two general criteria to the papers within each tradition. First, the research had to have a substantial degree of external validity (Bracht & Glass, 1968). Our basic concern was with the research's ecological validity: The research had to be performed in an actual school setting and employ school-like learning tasks. Such tasks had to be subject-matter centered, coming for the most part from a textbook or other existing curricular material. They also had to be relatively complex, containing a variety of ideas and behaviors to be learned. And they had to be time-consuming, in the sense that they required at least several hours and spaced (as opposed to massed) study periods to learn. In short, the research we sought had to employ learning tasks that were meaningful, complex, and relatively long. Second, the research had to have a high degree of internal validity (Campbell & Stanley, 1963). We first sought studies which utilized true experimental designs. But since so much school-based research does not utilize such designs, we also accepted studies which utilized quasi- or preexperimental designs, but only those that gave us reason to believe that the various experimental groups were roughly equivalent at the study's outset.

The studies reviewed here, then, represent what we believe to be the best of the mastery learning research to date. Yet, even these studies have some common flaws which must be noted. First, they usually used locally constructed dependent measures, but rarely did they describe in detail how these measures were constructed or discuss their content and construct validity. Consequently we usually had little way of knowing what the measures really tapped and were forced to rely on the investigator's descriptive label for the measure. Second, the studies typically did not describe their mastery treatments in adequate detail. Consequently, while we could readily ascertain that

[2] The following dissertations were not available: Baley (1972), Cioch (1974), Fehlen (1973), Nance (1974), Sanderson (1973), and Wyckoff (1974).

the researcher had implemented the basic features of a LFM or PSI approach, we had little idea of exactly how and how well the features had been implemented. Third, the studies often failed to describe their nonmastery treatments in any detail. For example, the nonmastery treatments were simply labeled as the "traditional" or the "standard" lecture-discussion treatments. Thus when the results of the mastery treatments were compared with the results of the nonmastery treatments, we often had only a general idea of what was being compared to what.

Of course, none of these flaws is peculiar to mastery learning research. Most instructional research has historically been weak in terms of measuring the dependent variables and in specifying the experimental treatments, especially the control treatments. Nevertheless, we caution the reader to keep them in mind.

The Type 1 Research

Perhaps the earliest and the most widespread type of mastery learning research has been addressed to the assumption that virtually all students can learn well if each student receives appropriate instruction. Both the LFM and PSI strategies propose that all students possess fundamentally the same capacity to learn and learn well, but that each student's capacity might have to be tapped in different ways. So a host of researchers has performed studies to test whether mastery approaches to instruction would allow more students to learn better than has traditionally been the case. We would label such studies as the "Does it work?" or Type 1 mastery learning research.

The early Type 1 studies tended to be fairly restricted in scope. They were executed in basic courses that were required, structured, "closed," and emphasized convergent thinking (Bloom, 1971). For example, most LFM strategies were initiated in core elementary school subjects such as basic mathematics, while most PSI strategies were tried in college subjects such as introductory psychology. Furthermore, the objectives to be taught for mastery were typically drawn from introductory textbooks. Hence, the objectives usually asked no more of the student than what most textbooks often ask: "lower order" cognitive behaviors such as knowledge and comprehension (Bloom, 1956).

The recent Type 1 studies, however, have become broader. They are being executed in courses that are intermediate or advanced, elective, loosely structured or nonstructured, "open," and amenable to divergent thinking. For example, there is increased use of mastery strategies in courses in the social sciences and the humanities. Moreover, the objectives to be taught for mastery are being formulated from a wider range of curricular materials. And these objectives are increasingly asking the student to perform "higher order" cognitive behaviors such as application, synthesis, and analysis (Bloom, 1956).

To illustrate the nature of the recent Type 1 research, consider the following examples:

TABLE 1A
LFM Cognitive Studies

Study	Grade Level	Student Type [1]	Sample Size [2]	Number of Classrooms	Subject Matter	Duration	Type of Experimental Design [3]	Learning Measures [4]
Anderson (1973)	8	Advantaged	Exp. = 57 Con. = 26	3	Matrix algebra	1 week	6. Posttest only, control group	Achievement *
Anderson (1976a)	1–6	Advantaged	Exp. = 195 Con. = 195	24	Mathematics	9 months	10. Nonequivalent control group	Achievement *† Retention (4 months) *
Block (1972)	8	Advantaged	Exp. = 64 Con. = 27	4	Matrix algebra	1 week	4. Pretest-posttest, control group	Achievement * Retention (2 weeks) *
Block (1973b)	8	Advantaged	Exp. = 27 Con. = 15	2	Matrix algebra	1 week	4. Pretest-posttest, control group	Achievement * Retention (2 weeks) *
Block & Tierney (1974)	College	Advantaged	Exp. = 30 Con. = 14	1	European historiography	10 weeks	5. Modified Solomon 4 group	Achievement *
Burrows & Okey (1975)	4–5	Advantaged & disadvantaged	Exp. = 63 Con. = 21	4	Geometry	2 weeks	6. Posttest only, control group	Achievement * Retention (2 weeks) *
Fiel & Okey (1974)	8	Advantaged	Exp. = 60 Con. = 30	4	Graphs	1 week	6. Posttest only, control group	Achievement *
Glasnapp et al. (1975)	College	Advantaged	Exp. = 207 Con. = 189	10	Measurement	1 semester	6. Posttest only, control group	Achievement *
Hymel (1974)	High school	— (all males)	Exp. = 64 Con. = 77	—	Algebra	10 weeks	6. Posttest only, control group	Achievement *
Jones (1974)	7	Advantaged & disadvantaged	Exp. = 206 Con. = 190	20	Social studies	4 weeks	6. Posttest only, control group	Achievement * Retention (3 weeks) *
Jones et al. (1975)	Junior college	Disadvantaged	Exp. = 248 Con. = 265	14	English Business Economics Biology Social sciences	1 semester	3. Static group comparison	Achievement *
Kim et al. (1974)	2	Advantaged & disadvantaged	Exp. = 906 Con. = 576	20	Moral education Korean Arithmetic	2–4 weeks 8 months	6. Posttest only, control group	Achievement *
Lee et al. (1971)	5–6	Advantaged	Exp. = 7409 Con. = 5095	179	Arithmetic Science	—	10. Nonequivalent control group	Achievement *
Okey (1974)	3–4	—	Exp. = 66 Con. = 64	5	Fractions	2 weeks	6. Posttest only, control group	Achievement *
Okey (1975)	Primary grades	—	Exp. = 356 Con. = 356	14	Mathematics Language arts	4 weeks 1 semester	7. Time series	Achievement *
Poggio (1976)	College	Advantaged	Exp. = 102 Con. = 90	10	Measurement	—	6. Modified posttest only, control group with repeated measures	Retention (4,7,10,13,16 months) *
Wentling (1973)	High school	Advantaged (all males)	116	6	Auto mechanics	5 weeks	10. Nonequivalent control group	Achievement * Retention (3 weeks) *

[1] If an explicit description of sampled population was not provided in the study, subjects were classified according to piecemeal information drawn from throughout the study. The term advantaged is used merely in contrast to the term disadvantaged; it does not imply special or superior students.

[2] Exp. = experimental group; Con. = control group.

[3] Experimental designs classified according to Campbell & Stanley (1963); numbers designate their types of design.

[4] * indicates locally constructed tests used; † indicates standardized tests used.

TABLE 1B
PSI Cognitive Studies

Study	Grade Level	Student Type [1]	Sample Size [2]	Number of Classrooms	Subject Matter	Duration	Type of Experimental Design [3]	Learning Measures [4]
Abraham & Newton (1974)								
Study 1	College	Advantaged	Exp. = 65 Con. = 516	—	Economics	1 quarter	3. Static group comparison	Achievement †
Study 2	College	Advantaged	Exp. = 89 Con. = 300	—	Economics	1 quarter	3. Static group comparison	Achievement †
Study 3	College	Advantaged	Exp. = 93 Con. = 276	—	Economics	1 quarter	3. Static group comparison	Achievement †
Anderson & Artman (1972)	College	Advantaged	Exp. = 13 Con. = 14	2	Physics	—	10. Nonequivalent control groups	Retention (15 months) *
Billings (1974)	College	Advantaged	Exp. = 37 Con. = 36	2	Economics	—	10. Nonequivalent control group	Achievement †
Born et al. (1972)	College	Advantaged	1. Exp. = 7 2. Exp. = 12 3. Exp. = 10 Con. = 12	1	Psychology	1 quarter	6. Modified posttest only, randomized blocks	Achievement *
Born & Davis (1974)	College	Advantaged	Exp. = 63 Con. = 31	2	Psychology	1 quarter	10. Nonequivalent control groups	Achievement *
Breland & Smith (1974)	College	Advantaged	Exp. = 266 Con. = 280	—	Introductory psychology	1 semester	3. Static group comparison	Achievement * Retention (6 months) *
Coldeway et al. (1974)	College	Advantaged	Exp. = 30 Con. =35	3	Psychology	1 quarter	10. Nonequivalent control groups	Achievement *
Cole et al. (1975)	College	Advantaged	Exp. = 40 Con. = 17	2	Behavior modification	—	10. Nonequivalent control group	Achievement *
Cooper & Greiner (1971)	College	Advantaged	Exp. = 42 Con. = 45	2	Psychology	1 semester	10. Nonequivalent control group	Achievement * Retention (5 months) *
Corey & McMichael (1974)	College	Advantaged	Exp. = 19 Con. = 18	2	Psychology	—	10. Nonequivalent control group	Retention (10 months) *
Corey et al. (1970)								
Study 1	College	Advantaged	Exp. = 58 Con. = 138	2	Psychology	—	3. Static group comparisons	Retention (4 months) *
Study 2	College	Advantaged	Exp. = 120 Con. = 204	2	Psychology	1 semester	3. Static group comparison	Achievement *
Johnston & Pennypacker (1971)	College	Advantaged	1. Exp. = 43 2. Exp. = 60 3. Exp. = 27 Con. = 15	4	Psychology	1 quarter	6. Posttest only, control group	Achievement *

Karlin (1972)	College	Advantaged	Exp. = 14 Con. = 25	2	History	2 weeks	6. Modified posttest only, matched group	Achievement *
Kulik, Kulik, & Carmichael (1974)	College	Advantaged	Exp. = 103 Con. = 60	2	Statistics	—	10. Nonequivalent control group	Achievement *
McMichael & Corey (1969)	College	Advantaged	Exp. = 194 1. Con. = 193 2. Con. = 184 3. Con. = 197	4	Psychology	1 semester	3. Modified static group comparison with 3 control groups	Achievement *
Morris & Kimbrell (1972)	College	Advantaged	Exp. = 39 Con. = 37	2	Psychology	—	10. Nonequivalent control group	Achievement *
Nazzaro et al. (1972)	College	Advantaged (all females)	Exp. = 93 Con. = 68		Psychology	1 semester	10. Nonequivalent control group	Achievement * Retention (5 weeks) *
Philippas & Sommerfeldt (1972)	College	Advantaged	Exp. = 57 Con. = 77 Exp. = 54 Con. = 62	2 2	Physics	2 quarters	4. Pretest-posttest control group	Achievement *
Rosati (1975)	College	Advantaged	Exp. = 38 Con. = 37	2	Engineering dynamics	1 semester	10. Nonequivalent control group	Achievement *
Roth (1973)	College	Advantaged	Exp. = 63 Con. = 21	2	Engineering (digital systems)	1 semester	3. Static group comparison	Achievement *
Sheppard & MacDermot (1970)	College	Advantaged	Exp. = 168 Con. = 92	1	Psychology	1 quarter	6. Posttest only, control group	Achievement *

[1] If an explicit description of sampled population was not provided in the study, subjects were classified according to piecemeal information drawn from throughout the study. The term advantaged is used merely in contrast to the term disadvantaged; it does not imply special or superior students.

[2] Exp. = experimental group; Con. = control group.

[3] Experimental designs classified according to Campbell & Stanley (1963); numbers indicate their types of designs.

[4] * indicates locally constructed tests used; † indicates standardized tests used.

1. LFM and PSI procedures were used to teach upper division college students a quarter-long course in European historiography (Block & Tierney, 1974). The course focused on helping students to think "historically" and was designed to provide them with the methodological and valuing skills required by practicing historians. Students were expected to know these skills and also to be able to apply them to a previously unencountered situation. In this case the situation was Watergate and some of the historical events surrounding it.
2. LFM and PSI procedures were used to teach eighth-graders a portion of a course in geography (Ware, 1976). This portion focused on helping students acquire particular skills and concepts in the use of maps and globes. The students were asked to know the skills and concepts and to be able to apply them in solving unfamiliar map and globe problems.
3. A hybrid LFM–PSI technique was used to teach an interdisciplinary course in the new area of law and technology (Vanjo & Nicholson, 1975). The first three units on basic points of law served as the foundation for four additional units—product liability and consumer protection; environmental matters; commerce and inventions; and government policy and the impact of technology on the law. Students were expected to know the course material and to be able to apply it in the analysis of some hypothetical cases and in the completion of team projects (e.g., trial by computer; societal analysis of computerized marriage and divorce).
4. PSI techniques were used to teach several courses in philosophy. Berry (1974), for example, taught an introductory course entitled "Problems of Philosophy." The course focused on the main philosophic questions associated with three topics: our perception of external reality; the mind and its place in nature; God and his relation to the world. Students were expected to know the course material and also to be able to converse fluently about it.

In Tables 1A and 1B we have listed what we judge to be the soundest of the early and more recent Type 1 LFM and PSI studies, along with a brief description of each. In addition to meeting our general methodological criteria of external and internal validity these studies also met the following particular criteria. First, all of them compared the learning of mastery-taught and non-mastery-taught students using performance on identical end-of-course examinations rather than grades. As best we can determine, these examinations contained no items identical to those that the mastery-taught students received during their diagnostic-progress testing. Second, all of them used common school-learning criterion measures (Brownell, 1948) and, in particular, measures of student *achievement* and *retention.*[3]

[3] Measures of *transfer* and *response latency* are also common school-learning criterion measures, according to Brownell. We will not focus on the impact of mastery strategies on student transfer measures, since all but two of the transfer studies we reviewed—Block (1972) and Ware (1976)—used grades in a subsequent nonmastery-taught course as their measure of transfer and Ware (1976) failed to employ a nonmastery experimental treatment. We will discuss, however, the impact of mastery strategies on student response latency (i.e., study time) in a subsequent section (the Type 2 research).

In Table 2 we have summarized the results of these studies. Note that we have attempted to indicate *how well* mastery-taught students have learned relative to their nonmastery-taught counterparts, as well as *how much variability* they have exhibited in this learning. As we have proposed elsewhere (Block, 1974), if mastery approaches do in fact help more students to learn better than has traditionally been the case, then mastery-taught students should exhibit greater learning, as well as less variability in their learning, than nonmastery-taught students. That is, the mastery-taught students should not only learn better, they should learn more like one another.

What do the summary data in Table 2 indicate?

Degree of Learning. There are sufficient data, we believe, to conclude that mastery-taught students have exhibited greater learning, on the average, than their nonmastery-taught counterparts. In 97 comparisons of average achievement test scores, comparisons involving various types and numbers of students and various subject matter areas, mastery-taught students scored higher than nonmastery-taught students 89% of the time, and significantly higher 61% of the time. Likewise, in 27 comparisons of average retention test scores, comparisons involving retention intervals from a few weeks to many months, mastery-taught students almost always scored higher than nonmastery-taught students, and significantly higher 63% of the time.

How much better, on the average, have the mastery-taught students learned than their nonmastery-taught counterparts? To answer this question, first we decided to look at only locally constructed test data, as we felt that such data were more indicative of actual student learning than standardized test data. Second, we decided to focus on only the LFM achievement data and on both the LFM and PSI retention data. We felt the PSI achievement data might somewhat underestimate the learning of mastery-taught students, since PSI students usually did not have the same incentive to perform well on their final examination as the nonmastery-taught students. Recall that in PSI strategies, student performance on their final exam counts for little, if any, of their final grade. Third, for each of the comparisons in Table 2 we calculated a ratio which expresses the difference in average achievement or retention test scores between the mastery and nonmastery groups in the standard deviation unit of the nonmastery group. For example, in the Hymel (1974) study, the mean achievement score difference between the mastery and nonmastery group was 5.84 points and the standard deviation of the control group scores was 5.01 points, yielding a ratio of 1.17 in standard deviation units. We found that 81% of LFM achievement comparisons and 54% of the PSI and LFM retention comparisons reported variance data for our calculations. Finally, we averaged these ratios across the LFM achievement comparisons and across the LFM–PSI retention comparisons.

Our findings were as follows. On the average, the LFM-taught students scored .83, or approximately five-eighths of a standard deviation better than

TABLE 2
Summary of Type 1 Mastery Learning Research

	Achievement						Retention					
	Level of Learning				Variability of Learning		Level of Learning				Variability of Learning	
	(>>)	(>)	(<)	(<<)	(≤)	(>)	(>>)	(>)	(<)	(<<)	(≤)	(>)
PSI studies												
Abraham & Newton (1974) *	1	1	1	0	3	0						
Anderson & Artman (1972)							1	0	0	0	1	0
Billings (1974) *	0	0	1	0	—	—						
Born et al. (1972)	1	0	0	0	0	1						
Born & Davis (1974)	1	0	0	0	—	—						
Breland & Smith (1974)	1	0	0	0	1	0	1	0	1	0	1	0
Coldeway et al. (1974)	1	0	0	0	—	—						
Cole et al. (1975)	1	1	0	0								
Cooper & Greiner (1971)	1	0	0	0	1	0	1	0	0	0	0	1
Corey & McMichael (1974)							1	0	0	0	—	—
Corey et al. (1970)	1	0	0	0	—	—	1	0	0	0	—	—
Johnston & Pennypacker (1971)	0	0	1	0	—	—						
Karlin (1972)	1	0	0	0	—	—						
Kulik, Kulik, & Milholland (1974)	1	0	0	0	—	—						
McMichael & Corey (1969)	1	0	0	0	—	—						
Morris & Kimbrell (1972)	1	0	0	0	—	—						
Nazzaro et al. (1972)	1	0	0	0	—	—	1	0	0	0	—	—
Phillippas & Somerfeldt (1972)	0	2	0	0	—	—						
Rosati (1975)	1	0	0	0	1	0						
Roth (1973)	1	0	0	0	1	0						
Sheppard & McDermot (1970)	2	0	0	0	1	1						
PSI subtotal	17	4	3	0	8	2	6	0	1	0	2	1
LFM studies												
Anderson (1973)	2	0	0	0	2	0						
Anderson (1976a)	6	0	0	0	6	0	3	2	0	0	5	0
Anderson (1976a) *	3	8	4	3	17	1						
Block (1972)	2	1	1	0	4	0	2	2	0	0	—	—
Block (1973b)	3	0	0	0	2	1	3	0	0	0	3	0
Block & Tierney (1974)	0	1	0	0	—	—						
Burrows & Okey (1975)	1	0	0	0	1	0	1	0	0	0	1	0
Fiel & Okey (1974)	1	1	0	0	0	2						
Glasnapp et al. (1975)	1	0	0	0	—	—						
Hymel (1974)	1	0	0	0	1	0						
Jones (1974)	0	1	0	0	—	—	1	0	0	0	—	—
Jones et al. (1975)	7	0	0	0	3	4						
Kim et al. (1974)	2	0	0	0	0	2						
Lee et al. (1971)	4	0	0	0	3	1						
Okey (1974)	1	4	0	0	3	2						
Okey (1975)	7	7	0	0	9	5						
Poggio (1976)							0	5	0	0	—	—
Wentling (1973)	1	0	0	0	0	1	1	0	0	0	0	1
LFM subtotal	42	23	5	3	51	19	11	9	0	0	9	1
ML total	59	27	8	3	59	21	17	9	1	0	11	2

Note: The symbols in the headings indicate the following:

Level of Learning

(>>) Scores of mastery group statistically greater than scores of nonmastery group ($p < 05$).

(>) Scores of mastery group greater, but not statistically greater, than scores of nonmastery group.

(<<) Scores of mastery group less than, but not statistically less than, scores of nonmastery group.

(<) Scores of mastery group statistically less than scores of nonmastery group ($p < 05$).

Variability of Learning

(≤) Mastery group achievement variance less than or equal to nonmastery achievement variance.

(>) Mastery group achievement variance greater than nonmastery achievement variance.

The numbers in the columns indicate comparisons between mastery and nonmastery groups. In studies where data were aggregated over classrooms, only one comparison is made. In studies where multiple mastery groups were used, more than one comparison is possible. The individual statistical comparisons in 12% of the reported studies are not independent.

* Indicates studies where standardized tests were used for comparisons.

non-LFM-taught students on the achievement measures. Likewise, LFM–PSI-taught students scored .67, or two-thirds of a standard deviation better than nonmastery-taught students on the retention measures.

For readers not inclined to such numbers, we have also pictured our findings in the histograms in Figure 1. Here we have graphed the LFM achievement and LFM–PSI retention data for the mastery and nonmastery students. Though it is not possible to make within-study comparisons from these histograms, it can be observed that the score distributions for mastery-taught students tend to be somewhat different from the score distributions for the nonmastery-taught students, though the distributions do overlap.

To round out our picture of the effects that mastery strategies have had on student learning, let us single out the findings of several of the LFM studies in more detail: Anderson (1976a), Jones (1974), Kim, Cho, Park, and Park (1974), Lee, Kim, Kim, Park, Yoo, Chang, and Kim (1971), and Okey (1975).[4] We have chosen these studies because in each one an effort was made to test the applicability of mastery learning ideas on a relatively large-scale basis. Thus, the Table 2 comparisons reported for these studies are based on many classrooms, as opposed to a few.

What do the data from these larger scale studies indicate? Kim et al., Lee et al., and Okey all found that their mastery strategies had produced both significantly greater student achievement and significantly greater retention across classrooms. Anderson found that his mastery strategy produced significantly greater student retention and significantly greater achievement on locally constructed, objective-based measures but not on standardized achievement measures. And Jones found that his strategy produced significantly greater student retention. The findings of these larger scale mastery studies, therefore, are generally similar to the findings of the smaller scale studies which contributed most of the data in Table 2. Apparently on the large scale as well as the small, mastery strategies can improve student learning.

Variability in Learning. We have focused so far on how well the mastery-taught students have learned relative to their nonmastery-taught counterparts. Now we turn to how much variability they have exhibited in this learning.

There are also sufficient data, we believe, to conclude that mastery-taught students have typically exhibited less variability in their learning than nonmastery-taught students. In 80 comparisons of the variance in achievement test scores of mastery-taught and nonmastery-taught students, mastery students exhibited less variability 74% of the time. Likewise, in 13 comparisons of the variance in retention test scores of mastery and nonmastery-taught students, mastery students exhibited less variability 85% of the time.

To determine how much variability mastery-taught students have typically

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[4] Two other large-scale studies, Stice (1975) in the PSI tradition and Greene and Bridges (1975) in the LFM tradition, were excluded for methodological problems.

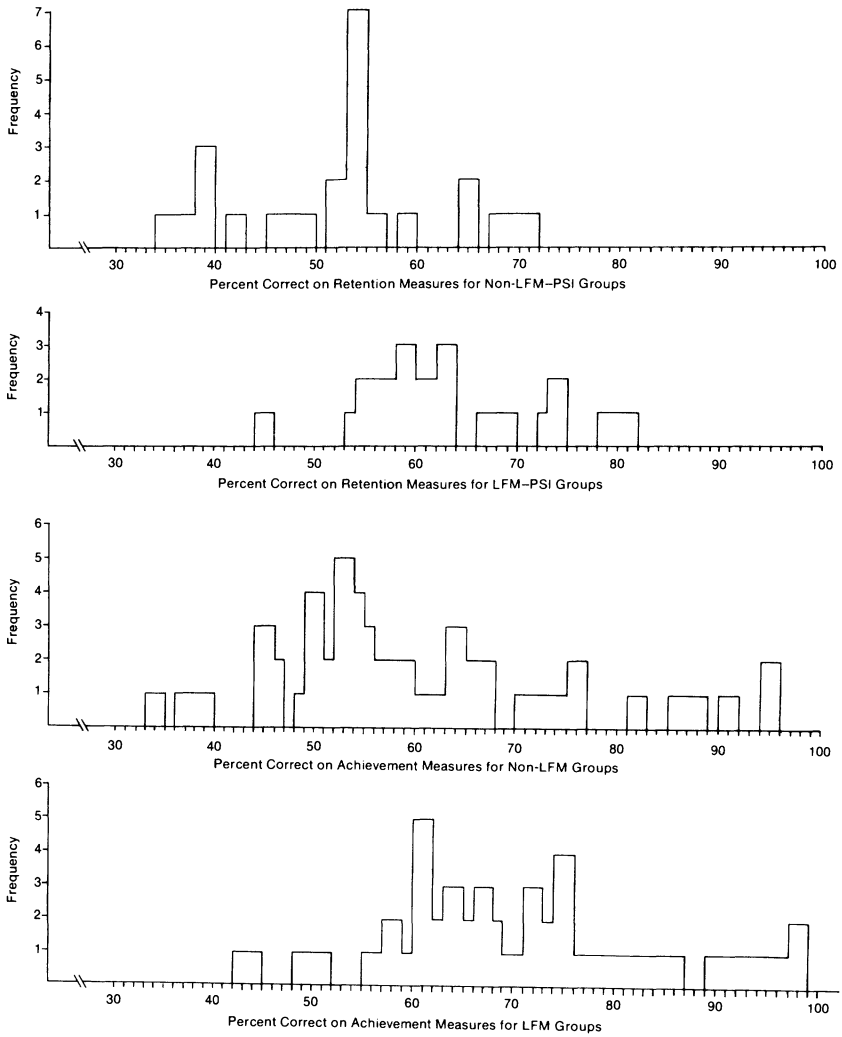

Figure 1. Histograms of percent correct on achievement and retention measures for mastery and nonmastery comparisons.

exhibited in their learning, relative to their nonmastery-taught peers, we proceeded as before in deciding to use only the LFM achievement data and LFM–PSI retention data. For the comparisons in Table 2 we then calculated percentages indicating how much more or how much less variance students in the mastery-taught group exhibited in their achievement and retention test scores relative to those students in the nonmastery group. We realized the danger of calculating such percentages, but we did not know of a better way to summarize the data. Again, 81% of the LFM achievement comparisons and 54% of the LFM–PSI retention comparisons provided usable variance data.

Our findings were as follows. When mastery-taught students have exhibited less variance in their achievement and retention test scores, they have typically exhibited 52% and 53% less variance, respectively. These figures may be compared to figures of 27% and 15% when mastery-taught students have exhibited more variance in their achievement and retention test scores.

Again, let us round out this discussion by examining the variability data from the larger scale mastery studies: Anderson (1976a), Kim et al. (1974), Lee et al. (1971) and Okey (1975). Anderson found that the variances in achievement and retention test scores were always less across classrooms for mastery-taught students than for nonmastery-taught students. Likewise, Lee et al. and Okey found that the variances in achievement test scores were typically less across classrooms for mastery-taught students. Only Kim et al. found that the variances in achievement test scores were more across classrooms for mastery-taught students.

Except for Kim et al., then, the findings from our few larger scale studies are again similar to those from the smaller scale studies which contributed most of the variability data in Table 2. On the large scale as well as the small, mastery strategies can apparently also reduce the variability with which students learn and especially with which they achieve. It remains to be seen how many of these reductions are artifactual and due to test ceiling effects. We suspect the number is small, since in many of the LFM and PSI studies the average scores on neither the achievement nor the retention measures reach the test's ceiling. It also remains to be seen if these reductions would still be manifest on other learning criterion measures besides measures of achievement and retention.

Kinds of Learning. Up to this point our primary concern has been to describe the learning of mastery-taught students in quantitative terms. We will now attempt to describe their learning in qualitative terms, focusing on the *kinds* of learning they have acquired and retained.

We identified several studies in Tables 1A and 1B in which the kinds of achievement fostered by mastery approaches to instruction have been explored. While the evidence provided by these studies is neither overwhelming nor very generalizable (they all used college students), it does suggest that mastery approaches may not only help students acquire complex, higher order cognitive behaviors but, when compared to nonmastery strategies, may be more likely to elicit higher order than lower order behaviors.

Born, Gledhill, and Davis (1972), Breland and Smith (1974), Cole, Martin, and Vincent (1975), McMichael and Corey (1969), and Sheppard and MacDermot (1970), for example, found that mastery-taught as opposed to nonmastery-taught students were better able to exhibit the operant achievement behaviors required to answer essay-type items. Their writings suggest that these behaviors include comprehension, application, analysis, synthesis, and evaluation skills (see Bloom, 1956). Further, with the exception of Breland and Smith, who used only essay-type items, all of these researchers found that mastery-taught as opposed to nonmastery-taught students were better able to exhibit these higher order operant behaviors than the lower order respondent behaviors required to answer multiple-choice-type knowledge items. Similarly, Block and Tierney (1974), Morris and Kimbrell (1972), and Glasnapp, Poggio, and Ory (1975) found that mastery-taught as opposed to nonmastery-taught students exhibited some respondent achievement behaviors better than others. In particular, the mastery students better exhibited the higher order respondent behaviors required to answer multiple-choice-type application and analysis items than they exhibited the lower order behaviors required to answer knowledge items.

We did find two studies which suggested that mastery strategies may not facilitate the acquisition of complex, higher order cognitive behaviors. The first study (Johnston & Pennypacker, 1971) calls into question our operant achievement findings. Johnston and Pennypacker found that the mastery-taught students did not perform better than the nonmastery-taught students on an end-of-course essay test. But this test consisted of only three items. The second study (Anderson, 1976a) raises some questions about our respondent achievement findings. In Anderson's study, three types of standardized, multiple-choice mathematics tests were used in addition to locally constructed, objectives-based exams. While the mastery-taught students performed significantly better than the nonmastery-taught students on all of the objectives-based tests and on the standardized tests in computation, they did not always perform better on the standardized tests in problem solving or in concepts. Anderson (personal communication) has pointed out, however, that the mathematics curriculum taught for mastery tended to place little emphasis on problem solving or concept learning.

Finally, let us consider the kinds of cognitive behaviors that have been retained by mastery-taught as opposed to nonmastery-taught students. We found two Type 1 studies addressed to this issue; a third by Riviere and Haladyna (1974) was a noncomparative study.

In the first of these studies, Poggio (1976) retested more than 250 college students over content previously learned under a self-paced, LFM approach or a lecture-oriented nonmastery approach (see Glasnapp et al., 1975). The students were retested using an examinee-sampling procedure with parallel forms of the multiple-choice final course exam for one and one-half years at three-month intervals. Poggio found that the mastery-taught students, in contrast to the nonmastery-taught students, retained significantly more knowledge behaviors (i.e., lower order behaviors) but did not retain significantly more comprehension, application or analysis-synthesis behaviors (i.e., higher order behaviors).

In the second of these studies, Breland and Smith (1974) retested mastery and nonmastery-taught students six months after the close of their instruction on two types of course-relevant concepts. One type of concepts was classified as basic, since they were derived from the core material covered in the course study guide. The other type was classified as difficult, since they were not derived from this basic material. Breland and Smith found that their mastery-taught as opposed to their nonmastery-taught students retained significantly more of the basic concepts but not significantly more of the difficult concepts.

Summary. The findings of the Type 1 mastery learning research suggest that mastery approaches to instruction do work. The approaches have not yet had as large effects on student learning as their advocates propose are possible, but they have had consistently positive effects. In quantitative terms, mastery approaches have usually produced greater student learning than nonmastery approaches, and they have usually produced relatively less variability in this learning. In qualitative terms, mastery approaches have typically helped students acquire higher order learning, though there is some question as to whether this higher order learning has been retained.

The Type 2 Research

In the early 1970s, some researchers began to look beyond the effects of mastery strategies on student learning. What, they asked, were some of the side effects of these strategies on their participants, the participants' schools, and the larger society outside these schools? The following general questions were addressed: Did mastery approaches have positive affective consequences for students? What were their time costs to students? Did the strategies help students learn how to learn? What were their role implications for teachers? What were their effects on the nature of school administration and curriculum development? And what were some of their outstanding social and economic costs and benefits?

It would be impossible to summarize here this "If it works, then what might follow?" or what we would term Type 2 mastery learning research. This literature is extremely diverse and, for the most part, highly speculative. We will focus instead on only the research that has explored the student-affective and time consequences of learning for mastery. The reader who wishes to peruse the other Type 2 literature is referred to the following basic sources: on the learning-to-learn effects of mastery strategies, Block (1974) and Kulik (1975); on their teacher role implications, Anderson and Block (1976), Block (1973a), Block and Anderson (1975), Keller and Sherman (1974), Spady (1974); on their administrative implications, Carmichael (1974), Fraley and Vargas (1975), Keller and Sherman (1974); on their curricular implications, Bloom (1971); on their sociological implications, Sherman (1974) and Spady (1974); and on their economic implications, Bible (1976), Christoffersson (1971), Garner (1973), H. M. Levin (1974, 1975), Sexton, Merbitz and Pennypacker (1975), Stice (1975), and Winkler (1975).

Affective Consequences. What have been the student-affective consequences of learning for mastery? A number of studies have addressed this question. In Tables 3A and 3B we have listed what we judge to be the soundest of these studies, together with a brief description of each, and in Table 4 we have attempted to summarize their results.

As Tables 3A and 3B indicate, the affective consequences of mastery strategies have been studied under a range of conditions, though certainly under a more limited range than their cognitive consequences. Yet the data in Table 4 indicate that across this limited range of conditions, the mastery approaches have typically elicited more favorable affective responses from students than their nonmastery counterparts and, in some cases, significantly more favorable responses. In particular, the mastery strategies have had a positive impact on students' interest in and attitudes toward the subject matter learned, self-concept (academic and more general), academic self-confidence, attitudes toward cooperative learning, and attitudes toward instruction.

The two potential affective costs associated with the mastery strategies seem to be increased test anxiety in LFM approaches and sometimes inordinately high levels of course withdrawals in PSI approaches. The increased test anxiety is probably a result of the fact that in LFM, a student's whole grade depends on his performance on a single final examination. The high levels of course withdrawals probably stem from the fact that in PSI, student learning is self-paced, and some students can procrastinate in beginning their learning until it is too late to earn an A. These students withdraw rather than earning a lesser grade.

Summary. At this point, therefore, the affective consequences of mastery strategies seem promising. We, like Ryan (1974), await more data from studies such as Anderson's (1976a), where students have been taught by mastery methods long enough that their novelty may have worn off. Some of the more favorable findings in Table 4 might be attributable to a Hawthorne effect. We also await data from studies where some follow-up measures have been taken on the mastery-taught students. We cannot presently determine whether the favorable affective responses of the mastery-taught students are just momentary expressions of enthusiasm or are more permanent expressions that carry

TABLE 3A
LFM Affective Studies

Study	Grade Level	Student Type [1]	Sample Size [2]	Number of Classrooms	Subject Matter	Duration	Experimental Design [3]	Learning Measures [4]
Anderson (1976a)	1–6	Advantaged	Exp. = 195 Con. = 195	24	Mathematics	9 months	10. Nonequivalent control group	Attitude (SM) † Academic self-concept †
Block (1972)	8	Advantaged	Exp. = 64 Con. = 27	4	Matrix algebra	1 week	4. Pretest-posttest, control group	Attitude (SM) †
Block (1973b)	8	Advantaged	Exp. = 27 Con. = 15	2	Matrix algebra	1 week	4. Pretest-posttest, control group	Attitude (SM) †
Block & Tierney (1974)	College	Advantaged	Exp. = 30 Con. = 14	1	European historiography	10 weeks	5. Modified Solomon 4 group	Attitude (SM) †
Ely & Minars (1973)	College	Advantaged	Exp. = 44	—	Freshman/ sophomore curriculum	1 semester	6. Posttest only, control group	General self-concept †
Jones et al. (1975)	Junior college	Disadvantaged	Exp. = 234 Con. = 72	—	Business Economics English Humanities Social sciences	1 semester 8 months	10. Nonequivalent control group	Academic self-concept † Withdrawal
Lee et al. (1971)	5–6	Advantaged	2,550	—	Arithmetic science	—	10. Nonequivalent control group	Academic confidence * Cooperative attitude †
Poggio et al. (1975)	College	Advantaged	Exp. = 207 Con. = 189	10	Measurement	1 semester	6. Modified posttest only, control group repeated measures	Test anxiety †
Wentling (1973)	High school	Advantaged (all males)	116	6	Automobile mechanics	5 weeks	10. Nonequivalent control group	Attitude (IS) †

[1] If an explicit description of sampled population was not provided in the study, subjects were classified according to piece-meal information drawn from throughout the study. The term advantaged is used merely in contrast to the term disadvantaged; it does not imply special or superior students.

[2] Exp. = experimental group; Con. = control group.

[3] Experimental designs classified according to Campbell & Stanley (1963).

[4] * indicates locally constructed tests used; † indicates standardized tests used. (SM) indicates subject matter; (IS) indicates instructional strategy.

TABLE 3B
PSI Affective Studies

Study	Grade Level	Student Type[1]	Sample Size[2]	Number of Classrooms	Subject Matter	Duration	Experimental Design[3]	Learning Measures[4]
Billings (1974)	College	Advantaged	Exp. = 37 Con. = 36	2	Economics	—	10. Nonequivalent control group	Attitude (IS) *
Born et al. (1972)	College	Advantaged	1. Exp. = 7 2. Exp. = 12 3. Exp. = 10 Con. = 12	1	Psychology	1 quarter	6. Modified posttest only, randomized blocks	Withdrawal
Born & Whelan (1973)	College	Advantaged	Exp. = 617 Con. = 1388	6	Psychology	—	3. Static group comparison	Withdrawal
Breland & Smith (1975)	College	Advantaged	Exp. = 255 Exp. = 131 Con. = 138	2	Intro. Psychology Ed. Psychology	1 semester	3. Static group comparison	Attitude (SM) *
Kulik, Kulik & Milholland (1974)	College	Advantaged	Exp. = 103 Con. = 60	2	Statistics	—	10. Nonequivalent control group	Withdrawal
McMichael & Corey (1969)	College	Advantaged	Exp. = 194 1. Con. = 193 2. Con. = 184 3. Con. = 197	4	Psychology	1 semester	3. Modified static group comparison with three control groups	Attitude (IS) * Withdrawal
Morris & Kimbrell (1972)	College	Advantaged	Exp. = 39 Con. = 37	2	Psychology	—	10. Nonequivalent control group	Attitude (IS) *
Philippas & Sommerfeldt (1972)	College	Advantaged	Exp. = 57 Con. = 77 Exp. = 54 Con. = 62	2 2	Physics	2 quarters	4. Pretest-posttest control group	Withdrawal
Sheppard & MacDermot (1970)	College	Advantaged	Exp. = 168 Con. = 92	1	Psychology	1 quarter	6. Posttest only, control group	Attitude (IS) * Withdrawal

[1] If an explicit description of sampled population was not provided in the study, subjects were classified according to piecemeal information drawn from throughout the study. The term advantaged is used merely in contrast to the term disadvantaged; it does not imply special or superior students.

[2] Exp. = experimental group; Con. = control group.

[3] Experimental designs classified according to Campbell and Stanley (1963).

[4] * indicates locally constructed tests used; (SM) indicates subject matter; (IS) indicates instructional strategy.

TABLE 4
Summary of Type 2 Mastery Learning Research

	Interest/Attitude toward Subject Matter				Attitude toward Teaching Method				Academic/General Self-Concept				Cooperative Attitude Academic Confidence				Anxiety toward Testing				Withdrawals from Course[1]	
PSI Studies	(>>)	(>)	(<)	(<<)	(>>)	(>)	(<)	(<<)	(>>)	(>)	(<)	(<<)	(>>)	(>)	(<)	(<<)	(>>)	(>)	(<)	(<<)	(>)	(<)
Billings (1974)					0	1	0	0														
Born et al. (1972)																					1	0
Born & Whelan (1973)																					3	0
Breland & Smith (1975)	1	0	0	0																		
Kulik, Kulik, & Milholland (1974)																					0	1
McMichael & Corey (1969)					1	0	0	0													1	0
Morris & Kimbrell (1972)					1	0	0	0														
Philippas & Sommerfeldt (1972)																					2	0
Sheppard & McDermot (1970)					1	0	0	0													1	0
Silberman & Parker (1974)					1	0	0	0														
PSI subtotal	1	0	0	0	4	1	0	0	—	—	—	—	—	—	—	—	—	—	—	—	8	1
LFM Studies																						
Anderson (1976a)	5	3	1	0					1	2	0	0										
Block (1972)	2	1	0	0																		
Block (1973b)	0	2	1	0																		
Block & Tierney (1974)	0	0	1	0																		
Ely & Minars (1973)									0	1	0	0										
Jones et al. (1975)									1	0	0	0									0	1
Lee et al. (1971)													2	0	0	0						
Poggio et al. (1975)																	1	0	0	0		
Wentling (1973)					0	1	0	0														
LFM subtotal	7	6	3	0	0	1	0	0	2	3	0	0	2	0	0	0	1	0	0	0	0	1
ML total	8	6	3	0	4	2	0	0	2	3	0	0	2	0	0	0	1	0	0	0	8	2

Note: The symbols in the heading indicate the following:
(>>) Scores of mastery group statistically greater than scores of nonmastery group ($p < .05$).
(>) Scores of mastery group greater, but not statistically greater, than scores of nonmastery group.
(<) Scores of mastery group less than, but not statistically less than, scores of nonmastery group.
(<<) Scores of mastery group statistically less than scores of nonmastery group ($p < .05$).
The numbers in the columns indicate comparisons between mastery and nonmastery groups. In studies where data were aggregated over classrooms, only one comparison is made. In studies where more than one affective measure was used, a comparison was made for each measure.
[1] Statistical analyses were not performed.

over into their subsequent work. Finally, we await more data from larger scale studies such as Anderson (1976a) and Lee et al. (1971). An approach that has promising affective consequences on a small scale need not have similar consequences on the large scale.

Time Consequences. Next to the question of what the affective consequences of mastery strategies have been, perhaps the question most frequently asked concerns what their student time costs have been. This general question has surfaced especially in connection with the group-based LFM strategy. It has usually taken two specific forms: Do mastery strategies hold back "faster" learners to accommodate "slower" learners? If not, where does one find the necessary class time to teach the "slower" students for mastery?

Some important assumptions about learners and the impact of mastery strategies on learners underlie these questions. Underlying the first question seems to be the assumption that some students always study fast and some study slowly, and mastery strategies cannot do much to reduce these individual differences. In particular, they cannot help the slower students study more like their faster classmates. Underlying the second question seems to be the assumption that teaching slower as well as faster students for mastery will require more class time than usual, and this additional time cannot be found. We will focus on the mastery learning research that addresses these assumptions.

We found several studies that bear on the issue of whether mastery strategies can help reduce individual differences in student study time. The first set of studies (Anderson, 1976b; Arlin, 1974; and Block, 1972, 1973b) relied on direct observational and self-report techniques to estimate student study time.[5] Moreover, they have been conceptually and procedurally replicative of one another. They were all performed under true experimental conditions, involved elementary as well as secondary school students of various socioeconomic origins, used hierarchically sequenced learning materials, and used individual based, self-paced instructional methods that allowed faster students to learn as quickly as possible.

The findings of these studies were as follows. Uniformly, they indicated that mastery strategies can have a homogenizing effect on individual differences in student study time. Arlin found that over the first seven units of an eight-unit imaginary science course, individual differences in elapsed study time were reduced from 7 to 1 to 4 to 1 by the mastery methods, and the mastery-taught students exhibited progressively less variability in their study time than the nonmastery-taught students. Moreover, he found that on the eighth unit, where both mastery and nonmastery-taught students were required to achieve to the same high criterion level, the mastery-taught students exhibited about

[5] There was one more study in this series—Garner (1973)—but it was excluded for methodological problems.

90% less variability in their study time than their nonmastery-taught counterparts. Likewise, Block and Anderson found that during a three-unit course in elementary matrix arithmetic, individual differences in elapsed study time were reduced from about 3.4 to 1 to about 2.1 to 1 by the mastery methods. Further, Anderson found that individual differences in the proportion of the elapsed study time that students spent actively engaged in learning were reduced from 2.1 to 1 to 1.4 to 1.

The second set of studies that have explored whether mastery strategies can help reduce individual differences in student study time used only systematic self-report time inventories (Davis, 1975; Lloyd & Knutzen, 1969; Rosati, 1975; Sutterer & Holloway, 1975). With one exception (Sutterer & Holloway) the findings of these studies also suggested that mastery strategies can have a homogenizing effect on individual differences in student study time. To be specific, Lloyd and Knutzen found that mastery-taught students exhibited virtually no individual differences in their study rates once they began to learn. Rosati found that mastery-taught students exhibited some individual differences in their study times, but the variability of these differences decreased over time. And Davis found that mastery-taught as opposed to nonmastery taught students began to study earlier and were more consistent in their expenditures of study time. Moreover his findings, like Anderson's, suggested that the mastery students were more consistent in using their study time for purposes of active engagement with the learning materials.

Having looked at the issue of whether mastery strategies can help reduce individual differences in student study time, we now turn to the issue of precisely how much total study time learning for mastery may require. Clearly, the reductions in individual differences in study time noted above were purchased at the price of additional study time for slower students early in the instruction. Was this price reasonable?

We found several studies which have explored the total student study time costs of learning for mastery versus not learning for mastery (Anderson, 1976b; Bailey, 1975; Block, 1972, 1973b; Born & Herbert, 1971; Cole et al., 1975; Hymel, 1974; Jones, 1974; Rosati, 1975; Roth, 1973; and Wentling, 1973). Most of these studies used only student self-report measures of study time, so we do not know how much faith to place in their findings. Still, taken as a whole, these findings indicate the following. Over the *short term,* the average total study time costs to students of learning for mastery have been substantially higher than the costs of not learning for mastery: Block, for example, found these costs to be about 70-80% higher when the mastery instruction lasted about two weeks. Over the *long term,* however, the average time costs to students of learning for mastery have been more reasonable: Wentling and Jones found that learning for mastery required 50% and 20% more student study time, respectively, when the mastery instruction spanned four to five weeks; and Anderson, Bailey, Born and Herbert, Cole et al., Rosati, and Roth found that it required from 10% more time to 25% less time when the mastery instruction spanned a full academic quarter or more. The one exception to this short term–long term pattern was Hymel's study, which indicated that learning for mastery could still require about 56% more study time even when the mastery instruction spanned 10 weeks.

Finally, we turn to the research that has addressed the issue of where the additional study time needed to teach slower students for mastery might come from. To date, this research has explored two sources of this time.

The first source is the teacher himself. Several studies (e.g., Alschuler, Dacus & Atkins, 1975; Conant, 1973; and Cusick, 1973) have suggested that many teachers spend only a small part of each school day actually teaching. Most of their school day is spent in the management of learners. Consequently, mastery researchers have attempted to shift teachers' attention from classroom enterprises central to the management of learners to enterprises central to the management of learning (Block & Anderson, 1975). At the core of their attempts has been the idea that teachers prepare and organize their mastery instructional plans, procedures, and materials outside of class and before the instruction begins, rather than in class. Preliminary, limited research suggests that such a procedure cuts daily preparation time and allows more time for interacting with students than might ordinarily be the case (Greene & Bridges, 1975).

The second source is the student. Research on individual differences in study time (e.g., Anderson, 1976b; Lloyd & Knutzen, 1969) and the withdrawal problem in PSI (e.g., Born & Whelan, 1973) have pointed to the fact that a key to the high study time of the slow learner is his tendency to procrastinate in beginning to study. Accordingly, mastery learning researchers, especially PSI researchers, have been devising and testing techniques whereby student procrastination can be minimized, if not eliminated. A host of techniques has been explored to date, such as: A/F grading (Whitehurst & Whitehurst, 1975); minimum progress requirements and incentives (e.g., Burt, 1975; Semb, Conyers, Spencer, & Sosa, 1975); teacher/peer pacing of instruction (e.g., Coldeway, Santowski, O'Brien, & Lagowski, 1974; Robin & Graham, 1974); frequent testing (e.g., Malott, 1971); and varying the size of the learning units (e.g., Born, 1975; O'Neill, Johnston, Walters, & Rasheed, 1975).

Summary. Our student time cost data suggest that mastery strategies might eventually help slower students to learn more like faster students do. The data also suggest that mastery strategies require much greater student study time than usual over the short term but more reasonable time over the long term, and that this additional student study time might be found by classroom techniques that cause both teachers and students to spend more time on learning as opposed to nonlearning activities. These are intriguing findings which raise hopes that teaching for mastery need not permanently hold back the faster student for the slower, nor "extend the education of some youngsters until they were oldsters" (Cronbach, 1967, p. 25). But they are also highly speculative findings. Clearly, the whole issue of the student time costs of learning for mastery bears much closer attention in the future.

The Type 3 Research

As it became clear through the early Type 1 and Type 2 research that mastery strategies might have positive cognitive, affective, and study time consequences for students, a third type of mastery learning research emerged. Researchers began to ask why mastery approaches work and to focus on variables or combinations of variables that might condition the successful or unsuccessful application of mastery learning ideas. Broadly speaking, they have addressed the following questions:

1. Do mastery strategies have the same effects on different kinds of students, i.e., students with different cognitive and affective entry characteristics?
2. Do some components of mastery strategies have greater effects on students than other components?

The complexity of the research designs used in most of these Type 3 studies (and space limitations) preclude a detailed treatment of each study and its findings. Besides, such treatments of a number of the studies already appear in several sources: Block and Burns (1975), Bloom (1976), Johnston (1975), Ruskin (1974), and Ryan (1974). We can, however, summarize what we believe to be the current gist of their findings.

Student-Entry Characteristic Studies. The student-entry characteristic studies have explored four classes of individual differences that might affect the applicability of mastery learning ideas. The first two classes may be viewed as affecting the students' readiness to learn *what* they will be taught. These are what we would term subject-matter-relevant cognitive and affective entry characteristics—those prior learnings and feelings about the subject matter that each student brings to his instruction (Bloom, 1976). The other two classes of these differences may be viewed as affecting students' readiness to learn by *how* they will be taught. These are what we would term method-relevant cognitive and affective entry characteristics—those prior learnings and feelings about the manner in which they will be taught that each student brings to his instruction (Block & Anderson, 1975).

The cognitive, subject-matter-relevant characteristics researched to date have consisted of the particular information or intellectual skills tapped by subject matter aptitude or diagnostic-readiness pretests (see, for example, Anderson, 1973; Block, 1970; Born et al., 1972; Bowen & Faissler, 1975;

Burrows & Okey, 1975; Fiel & Okey, 1974; T. Levin, 1975; Öczelik, 1973). The affective, subject-matter-relevant characteristics have included an openness to the subject matter, a desire to learn it, and the confidence to overcome difficulties in its learning, as indexed by subject matter interest and attitude scales (see, for example, Anderson, 1973; Block, 1970; and Öczelik, 1973).

The cognitive, method-relevant characteristics investigated, on the other hand, have consisted of the particular information-processing skills tapped by general cognitive ability measures, such as tests of intelligence or of verbal, reading, or other special mental abilities (e.g., Caponigri, 1972; Contreras, 1975; Ely & Hampton, 1973; Falstrom & Abbott, 1973; Hymel, 1974; Morris & Kimbrell, 1972; Nazzaro, Todorov, & Nazzaro, 1972; Pearson, 1973; Riviere & Haladyna, 1974). In contrast, the affective, method-relevant characteristics studied have included openness to the method of instruction, a desire to learn by it, and confidence to persevere in the face of difficulties posed by the method, as indicated by attitude-to-instruction scales and general or specific personality measures (e.g., Anderson, 1973; Billings, 1974; Born et al., 1972; Falstrom & Abbott, 1973; Newman, Young, Ball, Smith, & Purtle, 1974; Öczelik, 1973; Poggio, Glasnapp, & Ory, 1975; Reynolds & Gentile, 1975).

The findings from these student-entry characteristic studies indicate that individual differences typically affect the impact of mastery strategies on students' learning. In other words, the strategies usually do not *eliminate* the effects of these differences. But they have sometimes helped to *minimize* their effects, especially the effects of the cognitive differences (Anderson, 1973; Born et al., 1972; Burrows & Okey, 1975; Hymel, 1974; Nazzaro et al., 1972). In these cases, students who have been "weak" in subject-matter-relevant and/or method-relevant cognitive entry characteristics have learned more like their "stronger" peers. The two keys to the improved learning of the former students have seemed to be that they were asked to meet a high unit mastery requirement and they did meet that requirement through the use of unit feedback/correction procedures.

Component Studies. Mastery researchers have also begun to explore the impact on student learning and study behavior of nearly every component of mastery strategies. These components and examples of studies considering them are:

1. Instructional objectives and study questions: Bassett and Kibler (1974), Bowen and Faissler (1975), Burrows and Okey (1975), Collins (1970), T. Levin (1975), and Semb (1975).
2. Learning-unit size: Born (1975), O'Neill et al., (1975), and Semb (1974).
3. Unit pacing: Calhoun (1973), Coldeway et al. (1974), Robin & Graham (1974).
4. Unit social organization: Caponigri (1972), Ware (1976).
5. Unit feedback instruments: Blackburn, Semb, and Hopkins (1975), Malott (1971), Semb (1975).

6. Unit mastery requirement: Anderson (1973), Block (1972, 1973b), Calhoun (1973), Carlson and Minke (1975), Davis (1975), Johnston and O'Neill (1973), Semb (1974).
7. Unit correctives: Block and Tierney (1974), Burrows and Okey (1975), Calhoun (1973), Collins (1970), Farmer, Lachter, Blaustein, and Cole (1972), Fiel and Okey (1974), Hursh, Wildgen, Minkin, Sherman, and Wolf (1975), Lee et al. (1971).
8. Course grading policy: Johnston and O'Neill (1973), Sheppard and MacDermot (1970), Whitehurst and Whitehurst (1975).

While these components have been shown to have some independent and interdependent effects on student learning or study behavior, it has been the *unit mastery requirement* that has consistently produced the strongest effects. The failure to impose a unit mastery requirement or to ensure that the requirement has been met has tended to produce less achievement and retention and less consistent study behavior than the imposition of a requirement and the meeting of that requirement. Further, the imposition and meeting of different unit mastery requirements have had different student effects. The more stringent the requirement and its enforcement, the better and more similarly have students studied and learned. The less stringent the requirement and/or its enforcement, the poorer and less similarly have they studied and learned. A unit mastery requirement of a 90% correct score on at least one of the unit diagnostic-progress tests has proved optimal (Block, 1972, 1973b; Johnston and O'Neill, 1973).

Summary. The findings of the Type 3 student-entry characteristic studies dovetail, then, with the findings of the Type 3 component studies in suggesting that it has been the unit mastery requirement and the meeting of that requirement that have exerted primary influence over student learning. Why has this been the case? We suspect the answer lies in the findings of the Type 3 studies that have explored the relationships among various unit mastery requirements, student study time, and student achievement (see, Anderson, 1976b; Block, 1972, 1973b; Davis, 1975). These studies suggest that in mastery strategies it is the quality and quantity of student study time, not the quantity alone, that ultimately affect achievement (Block & Burns, 1975): The greater the elapsed study time and the greater the proportion of that time that is actively spent in learning, the greater the achievement. These studies also suggest that the meeting of various unit mastery requirements can have a decided impact on the quality and quantity of student's study time. The higher the unit mastery requirement, the greater the quantity of elapsed time spent studying and the greater the proportion of that time spent actively engaged in learning. Accordingly, we would hypothesize that the reason the unit mastery requirement and the meeting of that requirement have exerted such an influence over student learning is because they have affected the *quality and the quantity of student study time.*

The Type 4 Research

On the heels of the Type 3 mastery learning research, a fourth type of research is beginning to emerge. This research is attempting to translate what has been learned about why mastery learning strategies work into detailed statements of how they can be implemented.

This "How does it work?" or Type 4 research has concentrated on the development and dissemination of better teacher-training materials. In the LFM tradition, Block and Anderson (1975) have written a small volume on the application of mastery ideas at the elementary school level; Okey and Ciesla (1975) have developed a self-instructional module on teaching for mastery at the elementary and junior high school levels; and Anderson and Block (1976) have prepared a chapter on teaching educational psychology for mastery at the college level. In the PSI tradition, Keller and Sherman (1974) have assembled a set of handbooks for training college teachers; a number of packaged PSI courses have been developed for use at the college level; a national center has been established at Georgetown University to coordinate PSI teacher conferences and workshops and to publish a *PSI Newsletter;* and most recently a journal *(The Journal of Personalized Instruction)* has been established, to be devoted entirely to research and practice in PSI. And in both traditions, Biehler (1974) and Galloway (1976) have prepared general textbooks in educational psychology that are designed to instruct prospective elementary, secondary, and college and university teachers how to teach for mastery.

The mastery teacher-training materials produced and disseminated to date reflect years of experience in working with teachers to implement mastery ideas. The LFM materials of Block and Anderson (1975) and the PSI materials of Keller and Sherman (1974), for example, have each evolved out of over twelve years of experience in trying to implement mastery strategies both here and abroad. Thus the materials have been *informally* evaluated almost continuously. To our knowledge, however, only the teacher-training materials of Okey and Ciesla (1975) have been *formally* evaluated.

Okey and Ciesla's mastery teacher-training module has evolved over the last five years under the auspices of first the National Center for the Improvement of Educational Systems and then the National Center for Development of Training Materials in Teacher Education. The module is designed to train preservice and in-service elementary and middle-school teachers in basic mastery teaching areas, such as identifying and sequencing instructional objectives, developing evaluation measures, identifying learning difficulties, prescribing instruction, and measuring learning outcomes. It takes from five to ten hours to complete, utilizes audiovisual and written self-instructional techniques, and employs examples from mathematics, science, language arts, and other basic school subjects.

In the latest evaluation of the module (Okey, 1975), 20 in-service and 20 preservice teachers from four schools completed the module and then returned to the classroom. Each in-service teacher was paired with a preservice intern, and the pair taught the entire class of students a four-unit minicourse in mathematics or language arts. One member of the team was assigned to teach one-half of the class, using mastery methods on the first two units and nonmastery methods on the remaining two. The other member was assigned to teach the other half of the class in the reverse order. A counterbalancing procedure was used to control for which team member taught for mastery first. Student achievement over the first two units was then assessed, as was student achievement over the remaining two units.

Using all the data he could gather, Okey examined the following questions: What skills and attitudes did the teachers and interns bring to their study of the module? What skills and attitudes did they take away from their study? What were the cognitive and affective consequences for students when the teachers or interns implemented their mastery training in the classroom?

Okey found that approximately 90% of the teachers and interns knew virtually nothing about LFM theory and practice before studying the module, although many of the teachers were already using many LFM ideas in a piecemeal fashion, especially the ideas of remedial instruction, peer teaching, and the use of a variety of instructional methods and materials. By the end of the module, however, all of the teachers and interns scored 80 to 90% correct on a test covering LFM philosophy and practice. The trainees also exhibited improved attitudes toward the roles of testing, grading, and diagnosis in their teaching. Moreover, most said they planned to use mastery learning ideas and practices in their own classes (75%) or to recommend it to others (89%). Only a minority felt lukewarm about or uninterested in mastery learning (33%) or indicated that it takes too much work (40%).

Unfortunately, Okey did not formally observe the trainees to see whether their mastery training had made a real difference in their teaching behavior. However, the students noted a perceptible change in their teacher's or intern's behavior when taught by mastery methods. For example, students saw that their teachers or interns were telling them what they were expected to learn, allowing them different amounts of time to learn, and using diagnostic tests to monitor their progress. These changes are consistent with mastery teaching.

The teacher training did have some positive effects on student achievement, though Okey was able to gather usable data for only about two-thirds of his 40 planned mastery vs. nonmastery comparisons. Average student achievement was greater under the mastery learning condition than under the nonmastery condition in all of the teacher-taught groups and in about half of the intern-taught groups; it was significantly greater ($p < .05$) in 50% of the teacher-taught groups and in about 33% of the intern-taught groups. Moreover, the variability in student achievement was less under the mastery condition than under the nonmastery condition in about three-fourths of the teacher- and intern-taught groups.

Okey's affective findings were not quite as promising as his cognitive findings, however. The few students polled did feel better, on the average, toward the class, the tests, the school, and themselves when taught by mastery methods rather than by nonmastery methods. But they did not feel significantly better.

Summary. Okey's findings suggested that both in-service and preservice teachers could be trained to teach for mastery and that learning how to teach for mastery does not require the acquisition of a whole set of new skills. Rather, it seems to require the addition of a few new skills (e.g., diagnostic testing skills) to an existing repertoire (e.g., the use of remedial instruction) and the orchestration of these new skills with the old (e.g., learning how to use diagnostic test results to guide the choice of remedial learning activities).

Okey's findings also suggested that once preservice and in-service teachers have been trained to teach for mastery, they can apply their training in the classroom. Moreover, the use of their training can pay off, at least in terms of their students' achievement and especially if the teachers have had prior teaching experience.

MASTERY LEARNING: SOME IMPLICATIONS

In most of this chapter we have provided a relatively microscopic view of the current state of mastery learning theory, practice, and research. We will close it by taking a more macroscopic view and asking: What does it all mean? What are the most important practical, theoretical, and ideological implications of the literature we have reviewed?

Practical Implications

We, like Carroll (1975), believe that the most important practical implication of the research is that mastery learning strategies may represent one of those major breakthroughs to the improvement of student learning for which the educational research and development community has been searching (e.g., Krathwohl, 1974). This belief is predicated on the fact that the strategies have met, wholly or in part, general research criteria that other approaches to teaching have often failed to meet (see Dunkin & Biddle, 1974). They have been used in schools from the primary to college and university level; they have produced certain desirable outcomes in students; and they have been taught to teachers.

Accordingly, we would propose that the research and development community might want to cultivate mastery strategies systematically so as to mine their benefits and to plumb their limits. The strategies might be sown first in basic skills areas and then in other elective areas. Further, they might be evaluated using multiple student-outcome measures—cognitive, affective, psychomotor, time, social and ecological measures—and self-report, behavioral, and observational techniques. Thus rather than speculating as to whether mastery strategies will produce a certain set of desired outcomes or whether they will work for this subject or that, we might put our speculations to empirical test.

We see two keys to the cultivation of mastery learning strategies. One key is dissemination of mastery ideas and practices to more preservice and especially in-service teachers. The dissemination techniques of PSI advocates (see the Type 4 research) might well serve as models. The other key is the development of better mastery teacher-training materials. Such materials might result from comprehensive product evaluations of the materials that are already on the market. They might also be derived from observational studies of mastery-oriented teachers. Curiously, there have only been two such studies to date: Harrison & Harrison, (1975) and Lee et al. (1971).

Theoretical Implications

We believe that the most important theoretical implication of the literature we have reviewed has already been illustrated by the work of Bloom (1976), Glasnapp (1976), Harnischfeger and Wiley (1975), Rice (1973), and Wiley and Harnischfeger (1974). The mastery learning literature can provide a base for the development of some new causal theories of *school learning.*

Such theories are sorely needed. Historically, our theories of learning in school have been drawn in large part from theories of *learning,* but by and large these theories of learning have proved difficult to translate into theories of instruction (Gage, 1964). The nexus of the problem, we believe, has been that most theories of learning have been developed, in large part, under psychological, social, and ecological conditions very different from the conditions posed by the school environment. Indeed, many of these theories have been developed in the "noise-free" environments of laboratories instead of the "noise-full" environment of the school, where even a simple directive over the school intercom can disrupt an entire class for about 10% of a 50-minute lesson (Alschuler et al., 1975). We would argue, then, that were we to possess some theories of learning that have been developed from data generated under the psychological, social, and ecological conditions characteristic of the school environment, these theories of *school learning* might be more readily translatable into better theories of instruction. Indeed, we suspect that the success of mastery strategies such as LFM can be traced in large part to the fact that LFM strategies have been derived from an explicit model of school learning.

To illustrate how the available mastery learning research might contribute to the development of school-learning theories, consider the emergent findings of the Type 3 research. If we read these findings correctly, then they point to some important but relatively overlooked sets of variables that may shape school learning.

One such set may have to do with the feedback/correction of student learning. Historically there has been much research in instruction on the role of feedback (knowledge of results) in students' learning. Yet as McKeachie (1974) has pointed out, the provision of feedback, even if the feedback is given in an informative way, is insufficient for optimal learning. The student must also be given some prescription describing what he can do to "correct" unsatisfactory results.

The available mastery learning research supports McKeachie's contention. Moreover, it indicates that the type of "corrective" prescription given (Block & Tierney, 1974; Burrows & Okey, 1975; Fiel & Okey, 1974), as well as the dosage of that prescription (e.g., Block, 1972, 1973b; Farmer et al., 1972), can make a difference in school learning. Especially useful have been prescriptions which do not ask students to restudy certain subject matter using the same instructional methods and materials as before. The prescription may ask the student to use different methods and materials which present the subject matter or involve the student in its learning in new ways (Block & Anderson, 1975). Or it may ask the student to brush up on some subject-matter-relevant entry characteristics (see Fiel & Okey, 1974).

A second set of relatively overlooked school-learning variables are those that determine the time students spend actively engaged in learning. Educators have long been concerned about the *quantity* of the time students spend in study, as evidenced by compulsory attendance laws and uniform study time periods. Yet the available mastery learning research suggests the *quality* of that study time should also be of concern. The proportion of study time that students spend actively engaged in learning has been found to be very strongly related to student achievement (see Anderson, 1976b; Öczelik, 1973). In fact, this proportion has seemed to be a far more consistent predictor of student achievement than the quantity of their study time (Anderson, 1973).

Ideological Implications

We believe that the major ideological implication of the literature we have reviewed is that it provides yet another concrete example of an emerging perspective in education regarding students and their capacity to learn. We see this perspective in the cognitive psychology literature which describes how students are now being taught to acquire certain cognitive operations (e.g., Piagetian operations) for which they have been presumed to be unready (see Glaser & Resnick, 1972). It is also apparent in the behavioral psychology literature which describes how students are being taught to control certain overt or covert self-behaviors (e.g., body temperature) which have heretofore been considered relatively uncontrollable (see Mahoney & Thoresen, 1972).

And it appears in the humanistic psychology literature describing how students are being taught to acquire certain cognitive and affective traits (e.g., altered states of consciousness, creativity, visual imagination, intuition) which they have rarely acquired in the past (Ornstein, 1972, 1973). This perspective points to the *alterability* of most student learning under appropriate instructional conditions and suggests that many students' capacities to learn and learn well have yet to be realized.

This ideological implication is by far the most important implication of the mastery learning literature. We, like Foshay (1973), are of the opinion that it is beliefs and not data that run schools, and we see signs that many school personnel, even the newest, believe that the learning of some students is *unalterable* under any instructional conditions. In a recent study, for example, Good and Dembo (1973) asked 163 in-service teachers to estimate the percentage of their students who would "really master the material" they had to teach. More than half of the teachers expected less than 50% of their students to do so, and only 6% expected to see 95% of their students "really master the material."

We are convinced that such beliefs about the unalterability of some students' learning need reassessment, and we see the emerging view of the alterability of virtually all students' learning as providing a basis for this reassessment. This view provides a counterpoint to the older view, thereby creating the conditions for a dialectic between those who cleave to the older view and those who hold the newer. Surely, some fresh perspectives on the real limits of students' capacities to learn and learn well should emerge out of this dialectic.

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