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ABSTRACT

Since the late 1960s when Benjamin Bloom outlined his mastery teaching strategy, mastery learning programs have been implemented, such as Learning for Mastery and the Personalized System of Instruction, and several experiments have been carried out to test whether the mastery learning technique has an effect on student achievement. This paper synthesizes research on mastery learning, examining outcomes in the areas of achievement, retention of learning, student affect, and related variables. A majority of the studies showed that mastery learning has a positive effect on achievement at all levels and for all subjects and results in positive affective outcomes for students and teachers. Several variables affect or are affected by mastery learning: student entry variables, curriculum, type of test, pacing, level of mastery, and time. (Contains 19 references.) (JDD)

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SYNTHESIS OF RESEARCH ON MASTERY LEARNING

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Synthesis of Research on Mastery Learning

Introduction

Mastery Learning, as we know it today, started with a basic assumption regarding student aptitude. In 1963 John Carroll (1963) proposed that student aptitude was not a fixed level of intelligence (e.g. I.Q.) or the level to which a child could learn a particular subject. Rather, he proposed that it was a measure of the time needed to learn a subject. Therefore, all children could learn. Degree of learning was proposed as a function of the time spent divided by the time needed. Time spent was a factor of perseverance and opportunity to learn. Time needed was a factor of learning rate, quality of instruction, and ability to understand the instruction.

From these basic Mastery Learning assumptions, two programs were developed. Bloom's (1968) Learning for Mastery (LFM) was a group based program where adaptations were suggested to the traditional unit instruction. Instead of one formative assessment at the end of the unit, Bloom proposed adding a second equivalent formative test. Should students not reach the level of mastery set for the unit, the first formative test would become a diagnostic tool to put students through a series of correctives and feedback in a teaching style different from the first introduction of the concepts. Those students reaching mastery would be put through a series of enrichments to extend their learning. Those not reaching mastery on the first formative test, would be given a second formative test.

The second program was Keller's (1968) Personalized System of Instruction (PSI). In this program learning is divided into short units. Lessons presented in the PSI system are often presented through written materials. Students move through these materials at their own pace and are given formative exams at the end of the unit. Students not meeting the mastery criterion level are expected to restudy the material until they can reach the criterion level on the exam.

Since the late 1960's when Bloom (1968) outlined his mastery teaching strategy in his article, "Learning for Mastery," several experiments have been carried out to test whether his technique has an effect on student achievement. Various authors have duplicated his experiment with similar results. Hymel (1982) cites one thousand articles and publications on mastery learning. Bloom (1984) and several of his students have refined and added to his methods to the point that mastery learning is approaching the same powerful effect as one-to-one tutoring.

What follows is a synthesis of major research articles regarding Mastery Learning. Often these articles were a meta-analysis of other research studies. Often these articles used Glass et al's (1981) method of meta-analysis. Using this method a literature search is used to find research articles on a particular topic. Criteria for acceptance are set a priori with respect to relevance to the topic and methodological adequacy. Two methods are used for analysis. The first and most simplistic form of analysis is the "box score." This is simply a percentage of studies showing positive results. The second means of analysis is by finding effect sizes. Effect sizes are generally computed as the difference between the experimental and control means divided by the control groups standard deviation. In order to make a qualitative judgment regarding effect sizes, Cohen (1965) has defined a "small" effect size as .25, a "medium" effect size as .50, and a "large" effect size as 1.0.

This synthesis of research examines the outcomes research regarding Mastery Learning in the areas of achievement, retention of learning, student affect, and other related variables.

Achievement

Seven research studies (Kulik et al, 1990a; Kulik et al, 1990b; Slavin, 1990; Guskey & Pigott, 1988; Willett et al, 1983; Guskey & Gates, 1985; and Block and Burns, 1976) were found incorporating research studies from the early 1970's to 1990. These seven reviews analyzed 279 studies. Of those articles reporting sample sizes, these studies incorporate research studies that included over 22,000 students. Studies reviewed

included experiments from kindergarten to college using both the group-based Learning for Mastery (LFM) programs and the individualized Personalized System of Instruction (PSI). Research reviewed experiments in all subject areas and dependent measures from standardized and locally developed criterion-referenced tests. Outcome data was analyzed using a meta-analysis technique reporting mean or median effect sizes (ES). A summary of the achievement data is shown in Table 1.

In Kulik et al's (1990a) first article on Mastery Learning, they examined 103 studies including experiments using Learning for Mastery (LFM) and Personalized System for Instruction (PSI) programs. Achievement was measured using both locally developed criterion referenced tests and standardized tests. A box score of their studies indicated that 96 out of 103 studies, or 93.2%, reported positive achievement results. In 69.8% of the cases, the difference in achievement gains was reported as statistically significant. The range in reported effect size gains was from . 22 to 1.58 standard deviations. The average effect size for all studies was .52 which is considered "medium" and is significant at the .001 level. Another way to summarize this data is that if it is assumed that the control group is at the 50th percentile, the Mastery Learning group would have achieved at the 70th percentile. Both PSI programs and LFM programs had similar positive gains. The LFM group-based program had higher gains (+.59 standard deviations vs. .48).

Slavin's (1990) study examined 17 experimental studies of Learning for Mastery using only standardized tests as outcome measures of achievement. He reported an average effect size gain of .27 which was considered small and not statistically significant. A similar, smaller effect size was found in Kulik et al's (1990a) original study regarding standardized test outcomes. However, in reanalyzing Slavin's data, Kulik et al (1990b) found an average achievement growth of .4 standard deviations on locally developed criterion-referenced tests and .1 standard deviations on standardized tests, both

Table 1

Synthesis of Mastery Learning Achievement Outcomes

Study	Number of Studies	Number + results	%+	Sample Size	Average *ES*	Range *ES*	*p*	Types of Cases
Kulik et al (1990a)	103	96	93.2%	NR	.52	.22-1.58	<.001	K-College, LFM & PSI, CRT's and standardized tests
Slavin (1990)	17	NR		NR	Median .27			K-12, LFM only Standardized tests
Kulik et al (1990b)	11	7	63.6%	NR	.4-CRT's .1-standardized test		<.01 <.05	11 studies from Slavin's study LFM, K-12
Guskey & Pigott (1988)	46	41	89.1%	11,532	.41-psych. .50-science .53 soc. stud. .60 language arts .70 math .94 elementary .48 high school .41 college	.02-1.70	<.001	LFM only, K-college
Willett et al (1983)	13	NR	NR		.64			K-12 science
Guskey & Gates (1985)	38	35	92.2%	8,074	.65-.94			LFM, K-college
Block & Burns (1976)	51	45	89.0%	2,767	.83			LFM, K-college
Totals	279	224	90.0%	22,373				

NR= not reported ES= effect size LFM= Learning for Mastery PSI=Personalized System of Instruction

of which were statistically significant. Kulik et al (1990b) warns that too few studies are available on achievement outcomes on standardized tests to draw a confident conclusion on Mastery Learning effects on standardized test achievement.

Guskey and Pigott (1988) analyzed 46 studies on Learning for Mastery using locally developed criterion-referenced tests to measure achievement from kindergarten to college. Forty-one out of 46 studies, or 89.1%, reported positive results. Effect size gains ranged from .02-1.70. Since there was not a homogeneity of variance for the studies selected, they could not report an overall effect size. However, they did report effect sizes for several content areas and levels: psychology, .41; science, .50; social studies, .52; language arts, .60; mathematics, .70; elementary, .94; high school, .48; and college, .41. One will note that these effect sizes range in the "medium" category.

Guskey and Gates (1985) analyzed 38 studies regarding Learning for Mastery. Thirty-five out of 38 studies, or 92.2%, reported positive achievement results using primarily locally developed criterion-referenced measures of achievement for grades kindergarten through college. Average effect sizes for achievement gains were .94 for the elementary level, .72 for the high school level, and .65 for college level studies. Average effect sizes for content areas were .49 for science, .72 for math, .72 for social studies, .77 for language arts, and .83 for psychology. An examination of these effect sizes will note that they range from the "medium" to "large" categories.

Willett et al (1983) examined 103 studies on achievement outcomes in K-12 science. 13 of the studies focused on group-based Mastery for Learning programs. The average effect size in these 13 studies was .64, a "medium" gain. In fact, of all the 103 studies, Mastery Learning was found to be the most effective instructional technique for science achievement gain.

The last of the seven reviews, Block and Burns (1976), analyzed 51 studies of experiments using Learning for Mastery (LFM) and Personalized System of Instruction (PSI) programs from the kindergarten through college levels. Forty-five out of the 51

studies, or 89%, reported positive achievement gains. 61% of the studies reported statistically significant gains. The mean effect size for achievement gains for these studies was .83.

A meta-analysis by Lysakowski and Walberg (1982) has similar findings and implications for Mastery Learning, especially the group-based Learning for Mastery programs since it incorporates correctives and feedback. They reviewed 54 studies involving 14,689 students on the instructional effects of cues, participation, and corrective feedback. The average effect size achievement gain for these forms of instruction was reported as .97, a "large" effect size.

Two other aspects of achievement were analyzed in studies cited above: the retention of learning and variability of achievement within groups. Regarding retention, Kulik et al (1990a) examined 11 studies that included data on retention of learning after a period of 18 weeks or more. They found an average effect size gain for Mastery Learning groups to be .71. In Guskey and Pigott's (1988) review, 5 studies were analyzed for retention of learning after 2 weeks to 4 months. Average effect size gains for Mastery Learning Groups were reported to be .55. Block and Burns' (1976) review found 27 studies dealing with retention of learning from 5 weeks to 15 months after initial instruction. They reported a .67 effect size gain for Mastery Learning groups. A summary of this data is presented in Table 2.

Table 2

Mean Affect Sizes for Retention of Learning

Study	Number of Studies Reviewed	Mean ES	Length
Kulik et al (1990a)	11	.71	18 weeks +
Guskey & Pigott (1988)	5	.55	2 weeks- 4 months
Block & Burns (1976)	27	.67	5 weeks- 15 months

Regarding variability, the assumption from Mastery Learning theory is that as more students achieve mastery, their within group variance should decrease. Kulik et al (1990a) examined 52 studies that reported variance data on achievement. They reported that Mastery Learning groups had only 77% of the variance of the control group. Block and Burns (1976) report 52-53% less variance in 80 studies examined. Although Anderson (1976) does not report variance figures, she reports that the amount of time required for students who did not meet the level of mastery on the first exam decreased over time while their mean scores increased on the first exam indicating a shift towards homogeneity. A summary of this data is presented in Table 3.

Table 3

Variance in Achievement

Study	Number of Studies Reviewed	% Variance of Control Group
Kulik et al (1990a)	52	77%
Block & Burns (1976)	80	52-53%

Student Affect

Five studies (Kulik et al, 1990a; Willett et al, 1983; Guskey & Pigott; 1988; Duby, 1981; and Block and Burns, 1976) reviewed 60 studies with student affect outcome data. Those reviews reporting statistics on affective measures indicated that 51 out of 60 studies, or 85.0%, reported positive results. Summary data for affective outcomes are shown in Table 4.

Table 4

Affective Outcomes of Mastery Learning Studies

Study	Number of studies	N reporting + results	% +	Average *ES*	*r*	*p*	Notes
Kulik et al (1990a)							
Attitude toward instructional method	18	16	88.9%	.63		<.001	K-college, LFM & PSI
Attitude toward subject	14	12	85.7%	.40		<.01	
Guskey & Pigott (1988)							
Attitude toward subject	16	13	81.3%	.10-1.33			K-12, LFM
Importance of subject							
Affect toward school							
Academic self-concept							
Grade expectations							
Attributions for learning outcomes							
Willett et al (1983)							
Affect	2	2	100%	.52			Science, K-12, LFM only
Duby (1981)							
Achievement & internal attributions	1	1	100%		.49-.59	<.05	College, LFM
Attributions and time-on-task					.30-.47	<.05	
Attributions and absenteeism					-.01--.14		
Block & Burns (1976)	9	7	77.8%			<.05	LFM, 6 studies reported significant results.
Attitude toward subject							
Attitutde toward teaching unit							
Academic self-concept							
Cooperative Attitude							
Anxiety toward testing							
Totals	60	51	85.9%				

In the Kulik et al (1990a) meta-analysis of studies, they reviewed 18 studies that included data on student attitude toward the instructional method. Sixteen out of 18, 88.9%, reported positive results. A mean effect size for this positive attitude gain was calculated as .63 which was statistically significant at the .001 level. Fourteen studies were reviewed for student attitudes toward the subject. In 12 cases, positive results were reported which resulted in a mean effect size gain of .40 which was statistically significant at the .01 level.

In Willett et al's (1983) review of science instructional methods, two studies were found dealing with Mastery Learning and reporting affective outcomes. Their article does not specify the type of affective outcome. However, they do report a .52 effect size gain for the Mastery Learning group.

Guskey and Pigott's (1988) review of Mastery Learning experiments reported 16 studies that measured student affect. Thirteen of the 16 studies, or 81.3%, reported positive gains in the areas of attitude toward subject, importance of subject, affect toward school, academic self-concept, grade expectations, and attributions for learning outcomes. Effect sizes reported ranged from .10 to 1.33.

Duby's (1981) study of 4 groups of college students reported positive and significant correlations between achievement and internal attributions. In addition, he reported a significant correlation between internal attributions and time on task. There was no significant relationship between internal attributions and absenteeism.

In Block and Burns (1976) review of experiments with Learning for Mastery, nine studies reported affective outcomes. These outcomes were attitude toward the subject, attitude toward teaching method, academic self-concept, cooperative attitude, and anxiety toward testing. They reported positive gains in 7 out of the 9 studies, or 77.8% of the cases. However, they did report an increase in test anxiety for Mastery Learning students in the one study reporting this outcome.

Other Related Variables

Other variables were found to be related to or affected by Mastery Learning. These variables include student aptitude, curriculum, level of mastery, time, teacher variables, type of test, and pacing.

In Kulik et al's (1990a) report, 13 studies reported on the ability of students entering a Mastery Learning situation in comparison to their achievement outcomes. In 9 of these studies, effects were stronger for the less able students, while in 4 studies they were stronger for the more able students. This would tend to agree with a conclusion reached in the Guskey and Pigott (1988) review. They reported higher achievement affect sizes at the elementary level decreasing to the college level. They speculated that the reason for this was that as students progress, their ability levels tend to vary more, resulting in less of an effect on achievement. In other words, although Mastery Learning can affect all ability groups, the amount of variance due to ability can affect achievement outcomes. Block and Burns (1976) in their meta-analysis found that while Mastery Learning tends to minimize the effect of cognitive and affective student entry variables, it does not eliminate their effects.

In terms of curriculum, Kulik et al (1990a) review of studies indicated higher gains in social studies. However, Guskey and Pigott (1988) reported the highest effect sizes in mathematics (.7) and Willett et al (1983) reported a greater effect size in science (.64) than that reported by Kulik et al (1990a).

In both the Kulik et al (1990a) and Block and Burns (1976) sthdies, the level of mastery had an effect on achievement outcomes. Both concluded that the higher the level, the greater the achievement results. Block and Burns also found that the grading policy of the class had an effect on achievement.

As may be predicted from Mastery Learning theory, time was found to be a factor in several of the studies. Kulik et al (1990a) reported that Mastery Learning groups spent an average 4% greater time. Anderson (1976) and Block and Burns (1976) reported that

over a period of time, less study time was required for slower students. Guskey and Pigott (1988) reviewed 8 studies where there was a .76 effect size gain in time-on-task. In two studies they found that student attendance increased and course attrition decreased with effect sizes of .38 and .85. Arlin (1984) raises the question of the time-achievement-equity dilemma. He found in his own study that while achievement is excellent, the range of time for slower students to learn is anywhere from 3 to 10 times that of the faster student. While achievement variance did decrease, it required 40% more learning time. The dilemma he poses is that if we wish to reach the goal of equity of achievement, are we ready to deal with the variance in time required?

Teacher variables were affected by Mastery Learning in the Guskey and Pigott (1988) study. They reviewed experiments indicating increased positive attitudes towards Mastery Learning by teachers, higher expectations for student achievement, more internal attributions of effect to teaching practices, and more positive feelings about their role as teacher. The range in effect sizes for these variables were .61 to 1.67.

Both the Kulik et al (1990b) and Slavin (1990) studies indicate that Mastery Learning achievement outcomes are affected by the type of measure used. While Kurlik reported a mean effect size of .52 for all studies, those using standardized tests had a .1 mean effect size. Slavin (1990) reported a .27 median effect size that was statistically insignificant whereas the Kulik et al (1990b) reported significance at the .05 level.

Pacing was defined as whether the instruction was presented in a group format and the amount of feedbacks and correctives. Group-based Learning for Mastery produced higher achievement gains than other forms of science programming in the Willett et al (1983) study and greater than the Personalized System of Instruction in Kurlik et al's (1990a) study. Block and Burns (1976) reported that instructional objectives, study questions, learning unit size, unit pacing, and unit social organizations appeared to effect student achievement. Like the strong effect shown in the Lysakowski and Wallberg (1982) study of correctives and feedback, the Kurlik et al (1990a) and Block and Burns

(1976) studies indicated that correctives and feedback had a positive effect on student achievement.

In combining several of these variables, Kurlik et al (1990a) reported that pacing (group vs. self), unit mastery level, type of test (local criterion-referenced vs. standardized), amount of quiz feedback, and the type of course had a multiple correlation of .51. In other words, these variables accounted for 25% of achievement variance.

Summary

Table 5 shows a "box score" of the 279 studies reviewed in these various studies. As will be noted in the table, a large majority of research studies shows that Mastery Learning does have a positive affect on achievement at all levels and for all subjects. Meta-analysis techniques seem to indicate that one could predict a "moderate" achievement gain. Also, research on Mastery Learning seems to indicate a large majority of positive affective outcomes for students and teachers. Affective outcomes from these reviews seem to indicate a "moderate" effect size gain. Several variables affect or are affected by Mastery Learning: student entry variables, curriculum, type of test, pacing, level of mastery, and time. Mastery Learning does take more time, but student attendance and time-on-task decreases while variance and time for remediation decreases over time. However, the time-achievement-equity dilemma continues as educators evaluate the cost-effectiveness of personnel and time resources.

Table 5

Summary "Box Score" of Mastery Learning Outcomes

Outcome	Number of Studies	Number Reporting Positive Results	%	Effect Size Range
Achievement	279	224	90%	.27-.94
Student Affect	60	51	85%	.10-1.33

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