Mastery Learning:

A Comprehensive Literature Review

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Abstract

In the late 1960s, Benjamin Bloom introduced the concept of "mastery learning" to the field of Education. Bloom (1968) outlined his belief that the majority of students could master any content that they are being taught, if they are provided the right environment and context. Bloom (1968) outlined five key variables that must be achieved in order to do so: (1) aptitude for kinds of learning; (2) quality of instruction; (3) ability to understand instruction; (4) perseverance; and (5) time allowed for learning, the key to mastery (p. 3-6).

Since Bloom's theory was shared, there have been two main implementations that have been trialed in the classroom: (1) Bloom's (1968) Learning for Mastery (LFM), and (2) Keller's (1968) Personalized System of Instruction (PSI). These implementations have been tested in order to determine the impact that mastery learning can have on student achievement. Research over the years has demonstrated that, majority of the time, mastery learning has a positive effect on student achievement (Anderson, 1994).

This paper will detail the key variables of mastery learning and highlight some of the major findings that have been recorded over the years. It will then discuss Prodigy's implementation of mastery learning in order to help facilitate improved student outcomes.

Mastery learning started with the idea that a student's ability is based on more than just their aptitude. This idea was put forward by John Carroll (1963) before Bloom's theory of mastery learning was introduced. Carroll (1963) believed that a student's aptitude should not solely be thought of based on a person's fixed intelligence level, but that it should be considered as the amount of time it takes that person to learn a subject. According to Anderson (1994), "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" (p. 2). This is where the basis of mastery learning was formed.

Bloom (1968) took this basis that Carroll had formed and used to it derive his main ideas regarding how every student can reach mastery. Bloom (1968) stated:

> Put in its most brief form the model proposed by Carroll (1963) makes it clear that if the students are normally distributed with respect to aptitude for some subject (mathematics, science, literature, history, etc.) and all the students are provided with exactly the same instruction (same in terms of amount of instruction, quality of instruction, and time available for learning), the end result will be a normal distribution on an appropriate measure of achievement (p. 2-3).

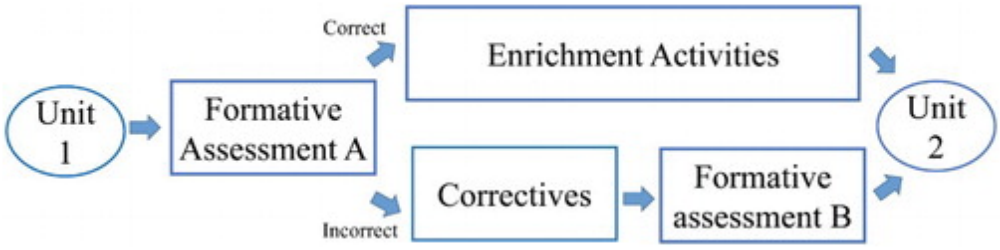
In order to change the normal distribution in terms of achievement so that all students are successful, the variables that lead to this result need to be altered. Bloom (1968) detailed five key variables that he believed, if executed correctly, would lead to the majority of students reaching mastery: (1) aptitude for kinds of learning; (2) quality of instruction; (3) ability to understand instruction; (4) perseverance; and (5) time allowed for learning (p. 3-6).

Aptitude for kinds of learning refers to the idea that students require a different amount of time to learn the same concept (Carroll, 1963). Students may have similar levels of aptitude according to aptitude tests but might require different amounts of time in order to reach those levels. When speaking about quality of instruction, Bloom (1968) highlights that, along with the time required, the quality of instruction also needs to be individualized for students. Carroll (1963, as cited in Bloom, 1968) describes the "quality of instruction in terms of the degree to which the presentation, explanation, and ordering of elements of the task to be learned approach the optimum for a given learner" (p. 4). In addition, the ability to understand instruction is also a key variable to mastery learning. This refers to the student's ability to understand and follow the specific teaching method of the teacher (Bloom, 1968). As students learn in different ways, it is important that the teacher is able to modify their teaching style in order to meet these different learning styles. In addition to their ability to understand instruction, students must demonstrate perseverance — that is, the student's willingness to spend time learning (Bloom, 1968). The final key variable to mastery learning is time allowed for learning. This indicates that students must spend the necessary time that it takes for them to learn a particular concept or subject, and that they also must be given the time necessary (Bloom, 1968). With all of these variables combined, Bloom (1968) believed that over 90% of students can achieve mastery.

From this approach, there were two main implementations of mastery learning formed: (1) Bloom's (1968) Learning for Mastery (LFM), and (2) Keller's (1968) Personalized System of Instruction (PSI). As shown in Figure 1, Bloom's (1968) LFM approach introduced an iteration of the traditional teaching approach for groups of students where a formative assessment was given to students at the end of the unit, and then the students would move on to the next unit. Instead, Bloom (1968) suggested that there should be a second assessment provided to students

that would either serve as the final assessment if all students had reached a stage of mastery or would serve as a diagnostic assessment if not all students reached a stage of mastery. For those students who did not reach a stage of mastery, intervention and corrective approaches would be taken to improve their mastery level before administering the second assessment. For those students whom reached a level of mastery at the first assessment, they would be provided with enrichment opportunities to further extend their thinking.

Figure 1: Mastery learning instructional process (Guskey, 2007 as cited in Yang, 2017)



The second approach was Keller's (1968) Personalized System of Instruction (PSI). Keller's approach suggested units be broken down into smaller parts, and that students work through those sections at their own pace. At the end of the unit, students would be given a summative assessment and those who didn't reach the stage of mastery would continue to study the same material — and not move on to the next unit — until they reach mastery.

Both approaches have been tested through a wealth of research to validate the impact that mastery learning can have on students' achievement and affect. A large body of research has been published that showcases, time and time again, students who are taught using mastery learning approaches reach higher levels of achievement as compared to students who are taught using more traditional methods (Anderson, 1994; Guskey & Pigott, 1988; Kulik, Kulik, &

Bangert-Drowns, 1990). Hymel (1982; as cited in Anderson, 1994) cited one thousand articles and publications that tested the different approaches to mastery learning. In Table 1 below, there are details of some of these studies.

Research Studies on Student Achievement

There have been several meta-analyses done on research performed regarding mastery learning as there has been many studies performed. Anderson (1994) has synthesized and summarized a lot of these meta-analyses. Table 1 (as shown in Anderson, 1994, p. 7) shows the research conducted related to student achievement.

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 lang. Arts .70 math .94 elementary .48 high school .41 college	.02 - 1.70	<.001	LFM only, K-college
Willent 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

This table highlights that across a total of 279 studies conducted, 224 or 90.0% of them showed positive results. For those studies that reported their sample size, there were 22,373 students sampled across Kindergarten up to College. As some studies did not report their sample size, this indicates that students were either tested using LFM or PSI. The studies completed by Kulik et al. (1990a) and Guskey & Pigott (1988) show effect size of nearly one standard deviation, indicating that the average student in a classroom that has implemented mastery learning

achieves the same level of mastery of only the top 15% of students in a class that has not implemented mastery learning.

In addition to these meta-analyses, there have been several studies suggesting that mastery learning has an even greater impact on students with special needs or students who are at-risk (Kulik, & Kulik, 1986; Ward, 1987; Walberg, 1990; Kulik et al., 1990).

In a study completed by Gusky (1990), the impact of mastery learning on mainstreamed special education students in an elementary school in Missouri was evaluated. In this study, 40 students who were considered to have mild disabilities or possessed at-risk status were placed into a mainstream classroom environment across 4th, 5th, and 6th Grade.

The classroom teacher administered a formative assessment and students who did not receive 80%-90% on this assessment worked with a special education teacher in the general education classroom who provided corrective instruction. Those students who did receive 80%-90% or higher on this initial formative assessment continued working with the classroom teacher on enrichment activities.

Researchers then looked at annual statewide achievement tests known as the Missouri Mastery Achievement Test (MMAT) to see how many students fell into the quintiles of those results. Before the mastery learning theory was introduced, 40% of students fell into the bottom two quintiles. However, after two years of the mastery learning approach, only 10% of students fell into the bottom two quintiles. According to Gusky (1990), "students' MMAT scores increased by 13.64% (over a one standard deviation increase), while learning disabled students in traditional resource programs gained only 3.89%" (p. 7).

Research Studies on Student Affect

Anderson (1994) also collected meta-analyses done on mastery learning and the impact it has on student affect. Table 2 below (as shown in Anderson, 1994, p. 9) shows the results of these meta-analyses.

Table 2: Affective Outcomes of Mastery Learning Studies

Study	**Number of Studies**	**Number + results**	**%+**	**Average ES**	**P**	**Notes**
Kulik et al (1990a) -Attitude toward instructional method -Attitude toward subject	18 14	16 12	88.9% 85.7%	.63 .40	<.001 <.01	K-college, LFM &PSI
Guskey & Pigott (1988) -Attitude towards subject -Importance of subject -Affect toward school -Academic self-concept -Grade expectations -Attribution for learning outcomes	16	13	81.3%	.10-1.33		K-12, LFM
Willett et al (1983) -Affect	2	2	100%	.52		Science, K-12, LFM only

Duby (1981) -Achievement & internal attributions -Attributions and time-on-task -Attributions and absenteeism	1	1	100%	.49-.59 .30-.47 .01-.14	<.05 <.05	College, LFM
Block and Burns (1976) -Attitude towards subject -Attitude toward teaching unit -Academic self-concept -Cooperative attitude -Anxiety toward testing	9	7	77.8%		<.05	LFM, 6 studies reported significant results
Totals	**60**	**51**	**85.9%**			

ES = effect size; LFM = Learning for Mastery' PSI = Personalized System of Instruction

Of 60 studies conducted, 51 or 85.9% of them demonstrated a positive impact on students' affect. These studies examined a variety of outcomes and attitudes that a student could have as a result of being part of a mastery learning environment. Overwhelmingly, the research points to increases in attitudes that students gain towards a particular subject when they are taught using a mastery learning approach.

In the Guskey and Pigott (1988) review (as cited in Anderson, 1994), they concluded that higher achievement affect sizes occurred at the elementary level and decreased as the student transitioned into college. Such findings could point to the importance of applying the mastery learning theory at younger ages so that students can evidence improved attitudes at younger ages.

Prodigy Math Game Applications

At Prodigy Education, we have worked hard to understand how to properly apply mastery learning to our game-based learning product, Prodigy Math Game. We have reviewed a wealth of studies that clearly demonstrate the impact that applying mastery learning has on students and have incorporated these research findings into the students' educational journey within our product. Several of the core principles of mastery learning have been applied in Prodigy Math Game including, but not limited to, aptitude for learning, perseverance, and time allowed for learning.

When considering the aptitude for learning (i.e., the amount of time it takes a student to master a particular subject), we intentionally did not include any time elements in our program. We want students to have the flexibility and freedom to take as little or as much time as needed on any given question, without having an artificial time restriction placed on them as several other games do. We also ensured that other features, such as our video lessons, can be replayed, fast forwarded, and rewound so that students can repeat or skip parts of the videos as necessary for their skill level.

Perseverance is defined by Carroll (1963) as the time the learner is willing to spend in learning. According to Bloom (1968), the amount of time a learner is willing to spend increases if they find the learning more rewarding. At Prodigy Education, we deeply believe that student engagement and their attitude towards math is core to a student's ability to learn. We have created an environment where students are motivated to spend the necessary time it takes for them to complete a task in order for them to progress throughout the game-play. By providing rewards and incentives for students to spend the necessary time, they can draw the connection

between what an increased effort can do to their skill set. We have also included specific features such as offering a second chance on questions if a student answers incorrectly on the first attempt, to again demonstrate to students that making mistakes is part of the learning process. Being willing to put in the effort to try again goes a long way in showing a student's perseverance.

The final key element in mastery learning is the time allowed for learning. In the traditional school system and classroom, every student is provided with the same amount of time to learn the same amount of content as their peers. What's important in mastery learning is that students are afforded the amount of time that they each individually need to achieve mastery. In Prodigy Math Game, we have created an adaptive algorithm that is directly aligned with this idea. As students move through our content at their own pace, the program consistently adapts to where they might need to spend more time. If a student shows signs of struggling on a particular piece of content, our algorithm determines what gaps might exist in their knowledge and provides them the time and help needed in order to fill those gaps so that they can move forward in their mastery journey.

Conclusion

When students are provided the correct approach and environment that caters to their individual needs, they are able to achieve a level of mastery. Our traditional education system and structure do not always naturally allow for this individualized environment. Therefore, it's important that educators understand mastery learning and what it's capable of achieving. At Prodigy Education, we want to help fulfill Carroll's and Bloom's visions of mastery learning, and afford every student around the world the ability to achieve mastery in their educational journey.

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