

A META-ANALYSIS ON DETERMINING THE GENERAL EFFECTIVENESS OF TEACHING MATHEMATICS USING MASTERY LEARNING STRATEGIES

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Abstract

The aim of this study was to analyze the effect of Mastery Learning Models on students' learning in the subject of mathematics. The studies which have been carried out so far have emphasized the positive effects of using Mastery Learning strategies that rely upon Bloom's model of school learning not just in teaching mathematics but in other subjects as well. This fact was also confirmed by the two meta-analyses conducted by James A. Kulik and Maxwell Okwudili Ede. The research included in the present study was quasi-experimental because the participants in the analyzed studies could not be randomly assigned to the two groups, the experimental group and the control group. A pre-test and a post-test were applied to determine the effects of the chosen strategies.

Keywords: *mastery learning, different learning strategies, efficient learning, interactive methods, correctives, progress, motivation*

1. INTRODUCTION

This research aims to provide a theoretical framework of the differentiated instruction strategies as well as a study which investigates the above-mentioned strategies combined with mastery learning models applied in the teaching of mathematics in a secondary school. Mathematics was always regarded as a more difficult subject to teach and especially to learn. This happens because solving math problems is not always based on using some algorithms but also on logical and creative thinking. It is not enough to know the theoretical notions. You must also have the necessary skills of using these notions when you try to solve a problem. We chose to investigate this subject in order to emphasize the fact that learning mathematics is great for the development of a student's logical and creative thinking and that mathematics can be fun due to all the different possibilities of finding a solution to a problem.

1.1 Mastery learning

John B. Carroll and Benjamin S. Bloom were the first to emphasize the concepts of *differentiated instruction* and *mastery learning strategies* even though the notion of mastery learning has been known since 1920.

In his study, *A Model of School Learning* (1963), John B. Carroll stated that not only the aptitudes and the skills of a student are responsible for the outcomes of one's learning. He thought that the level of performance is based on a function of the time spent on learning and the time needed for learning [1]. Using this principle, we can develop a teaching model which is similar to Carroll and Bloom's mastery learning models. We have to keep in mind the fact that every student is different and needs a differentiated learning strategy.

The research carried out by John Carroll has shown that most students can learn everything they are being taught if a mastery learning model is applied. In this regard, he stated five variables that lead to successful learning. The first three are related to *time* while the other two regard the acquisition of new knowledge. These variables are *aptitude*, *opportunity*, *perseverance*, *the ability to understand instruction*, and *the quality of instruction* [1].

Benjamin S. Bloom thought that not all students can reach their full potential in learning if they are given the time needed to learn and stated that instead of establishing such an unrealistic goal as reaching a maximum level of performance, one should consider setting a particular level for each task.

Almost 90 percent of the students can learn everything they have to learn in school very well and the main goal of the teacher is to find the means and the tools necessary to provide students the best learning conditions [2].

In Romania, a research based on applying differentiated instruction in schools has aimed to investigate the means for overcoming the difficulties students have because they fell behind with their learning. This kind of problems appear since the 2nd grade when most of the students are unable to meet the requirements. We are dealing with this issue nowadays especially that in mathematics the lack of prior knowledge leads to difficulties in learning new things.

The current research investigates the outcomes of students' learning after implementing a mastery learning model which implies the use of differentiated instruction in filling knowledge gaps for the students who face difficulties in learning. It also implies the individual tutoring for these students.

We wish to find answers for questions related to students' motivation, to the way they learn when they are not pressed for time, to the development of self-trust, to the feedback which students provide the teacher with regarding their attitude towards the new approach and the feelings that they experiment during activities.

The case studies reveal more details regarding the teaching and learning of mathematics and regarding the main changes that have been made so far, especially the ones related to the way students think and focus. These case studies reveal some of the individual solutions that can be applied in the teaching-learning process and which determine progress in learning and some of the means which are inappropriate for students [3].

The main features of the mastery learning model are dividing the content into small learning units, clear statement of the objectives, remediation lessons, formative and summative assessments, and immediate feedback [2].

James A. Kulik's meta-analysis [4] investigated 108 studies based on implementing mastery learning strategies. The studies were taken from two databases: ERIC – *Educational Resources Information Center* and *Comprehensive Dissertation Abstracts*. Thirty-six of these studies were based on Bloom's learning model while seventy-two of them regarded Keller's individualized system of instruction.

Maxwell Okwudili Ede [5] has analyzed 42 studies. The analysis of these studies revealed that 29 of them (69.04%) had findings registered as statistically significant while 13 of them (30.95%) had findings which were not statistically significant. It was proven that most of the analyzed studies registered positive outcomes of implementing mastery learning models.

2. DETERMINING THE GENERAL EFFECTIVENESS OF TEACHING

When we want to determine the general effectiveness of teaching we actually want to determine the success in learning for all students as a way of fulfilling John Amos Comenius' dream, "the art of teaching all things to all men".

The questions that require an answer are the following.

- a. Does implementing mastery learning strategies lead to better outcomes for students who face difficulties in learning and need more time to complete their tasks?
- b. Are mastery learning strategies the key to success in learning?
- c. Which are the variables that lead to mastery learning?
- d. Which are the variables that determine the effectiveness of teaching in mathematics?
- e. Is there a connection between mastery learning models and the effectiveness of teaching?

Syamsyuddin [6] stated that *effectiveness* can be defined as "a success level that can be reached by a good method to achieve a specific aim". The teaching process in mathematics must aim at the development

of thinking skills and of mathematical logic through methods such as CTL (Contextual Teaching and Learning Model), not based on learning by heart formulas and ways of solving problems.

3. OBJECTIVES OF THE META-ANALYSIS

The aim of this meta-analysis is to investigate the outcomes of previous studies in which researchers implemented a mastery learning model in teaching mathematics. We have also analyzed the size effect in each study, the average effect sizes for all studies and the mastery learning strategy influenced the teaching process and the students' level of performance.

4. METHODS

4.1 Related literature on mastery learning search

The relevant studies were identified using advances search in the following databases: ERIC, Web of Science, and ProQuest. The keywords used for the search were *mastery learning*, *approach*, *strategy*, *effectiveness*, and *math*. An example of a search string is: ts=("mastery learning" and math*) and (effect or effectiveness) and (approach or strategy)) or ti=("mastery learning" and math*) and (effect or effectiveness) and (approach or strategy)).

4.2 Selection of studies

Upon an elaborate search, we identified 64 studies which were based on implementing mastery learning strategies. After removing duplicates and revising the selected articles, we retained 32 studies to be analyzed. The other 32 studies were excluded because the implemented strategies were not related to teaching mathematics.

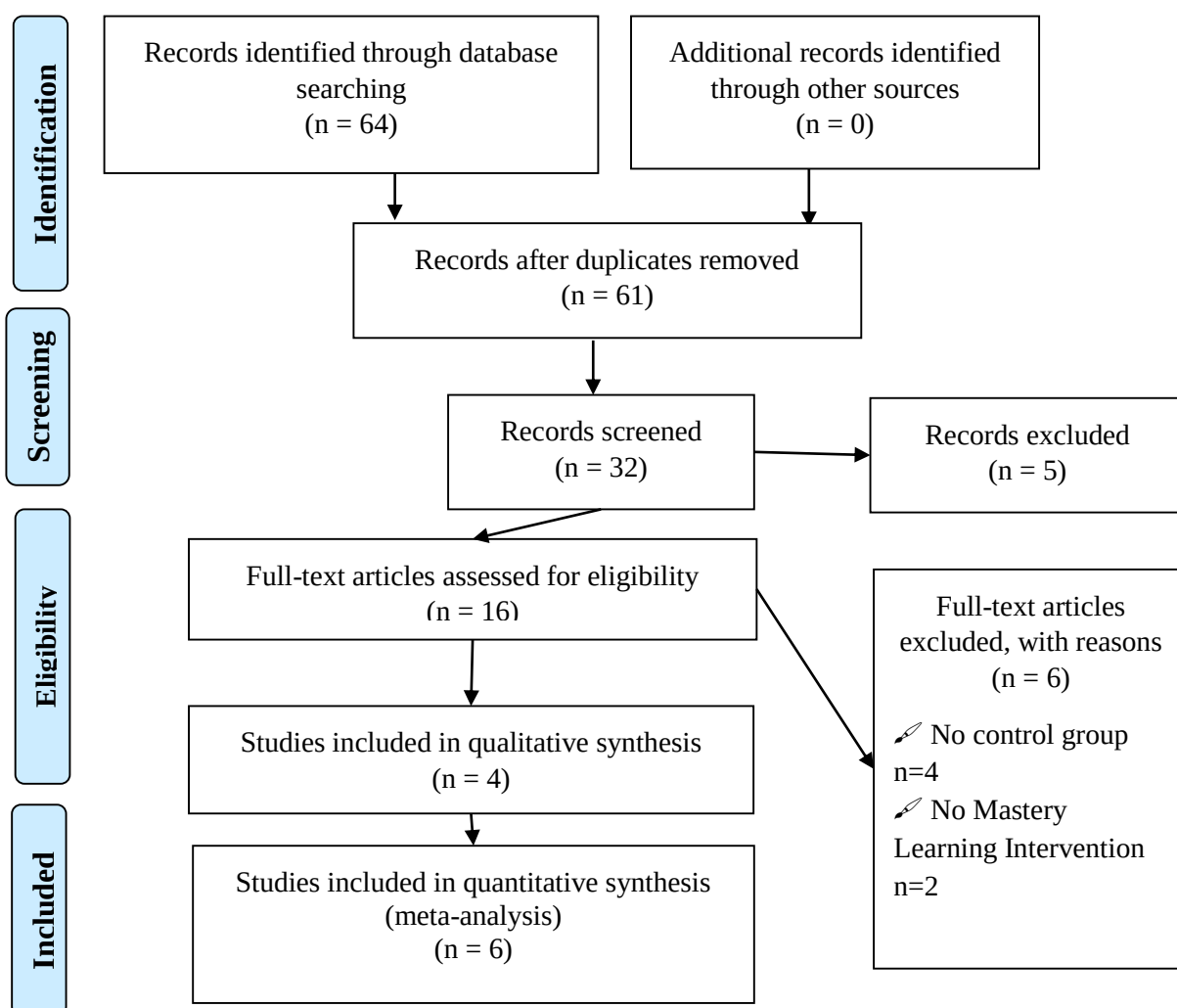


Fig. 1. Flow diagram of the study selection process

To be included in the current meta-analysis, a study had to meet the following criteria.

- The selected study had to be based on implementing a mastery learning strategy.
- The outcomes of the study had to be based on the comparison between the results registered in the pre-test and post-test for at least two groups: an experimental group and a control group. The studies which registered only the results from the post-test were excluded.
- The study had to focus on teaching mathematics.

4.3 Procedure

For each study we retained the following variables: study identification data (author and year of publication), the learning level of the students in the control group and in the experimental group, and the implemented teaching strategy.

Table 1. Characteristics of studies included in the meta-analysis

References	Level of control group	Level of experimental group	Implemented teaching strategy in the experimental group
Amiruddin, M.H. [7]	University	University	<i>mastery learning</i>
Clark, C. R. et al. [8]	University	University	
Lin, C. et al [9]	Secondary school 6 th grade	Secondary school 6 th grade	<i>mastery learning using computer games</i>
Pankaj, B [10]	Secondary school 5 th grade	Secondary school 5 th grade	<i>mastery learning approach</i>
Toheed, L., & Ph, D. [11]	High school 9 th grade	High school 9 th grade	<i>mastery learning strategy</i>
Yemi, T. M. [12]	High school 9 th grade	High school 9 th grade	<i>mastery learning approach</i>

Amiruddin [7], in his study *The Effects of a Mastery Learning Strategy on Knowledge Acquisition Among Aboriginal Students: An Experimental Approach*, published in *International Journal of Vocational Education and Training Research*, proclaimed that the mastery learning models be part of the learning strategies, especially for students in Malaysia. The participants in the study were 80 students and the outcomes revealed a significant difference between the knowledge of the students in the experimental group and that of the students in the control group.

Clark, Guskey, and Benninga [8] in their study *The Effectiveness of Mastery Learning Strategies in Undergraduate Education Courses*, published in *Journal of Educational Research*, confirmed the hypothesis according to which implementing mastery learning strategies leads to a higher level of performance in students' learning. There were 197 participants in the study, 55 of whom were in the experimental group.

Lin et al [9], in the study *Game-Based Remedial Instruction in Mastery Learning for Upper-Primary School Students*, used a mastery learning strategy based on computer games. The participants in the study were 62 students in the 6th grade. The aim of this study was to compare the effectiveness of teaching mathematics using games or videos in a mastery learning strategy. The outcome was that implementing a mastery learning strategy based on games is of great benefit to students regarding the acquisition of new information and the motivation to learn.

Pankaj [10], in his research *Effect of Mastery Learning Approach (MLA) on the Achievement in Mathematics of students with Mathematical Difficulties*, aimed at determining the general effectiveness of mathematics instruction using a mastery learning strategy. The participants in this study were 60 students in the 5th grade, divided equally in the two groups. The outcomes of the study showed a statistically significant difference between the pre-test and the post-test for the experimental group and between the experimental group and the control group. These data revealed the fact that the students who based their learning on a mastery learning model had better results than the other students.

Toheed and Ph [11], in their study *The Effect of Mastery Learning Strategy on Learning Retention of Secondary School Students in the Subject of Mathematics*, emphasized the fact that mastery learning strategies have an immediate effect on learning retention in mathematics. The main purpose of this study was to identify the effect of using mastery learning strategies on short-term learning and on long-term learning retention. The 96 participants in the study were divided equally in the two groups.

The study conducted by Yemi [12] and published in *European Journal of Alternative Education Studies*, called *Mastery Learning Approach (MLA): Its Effects on the Students Mathematics Academic Achievement*, analyzed the effect of implementing a mastery learning strategy in order to improve the results in learning mathematics. There were 80 students in the 9th grade who took part in this study (40 students in the experimental group and 40 students in the control group). The study was based on a quasi-experiment, and the post-test results showed a statistically significant effect in applying a mastery learning strategy.

5. STATISTICAL ANALYSIS. RESULTS

To estimate the effect size, we computed Hedge's g coefficient which is a formula based on the coefficient of determination and the correlation coefficient. Just like Cohen's d coefficient, a 0.2–0.5 value indicates a small size effect [13]. This would mean either that the null hypothesis is supported but there is no statistically significant effect or that the null hypothesis is rejected which would mean that the outcomes are not relevant in practice even though they are statistically significant.

A 0.5–0.8 value indicates a medium effect size [13]. This could be recorded by accident if the null hypothesis is not rejected. On the contrary, the effect is statistically significant and is important in practice. A 0.8 value or higher indicates a large effect size which shows that if the null hypothesis is rejected the test is statistically and practically significant [13].

A positive value of Hedge's coefficient indicated a superior efficacy of implementing mastery learning strategies.

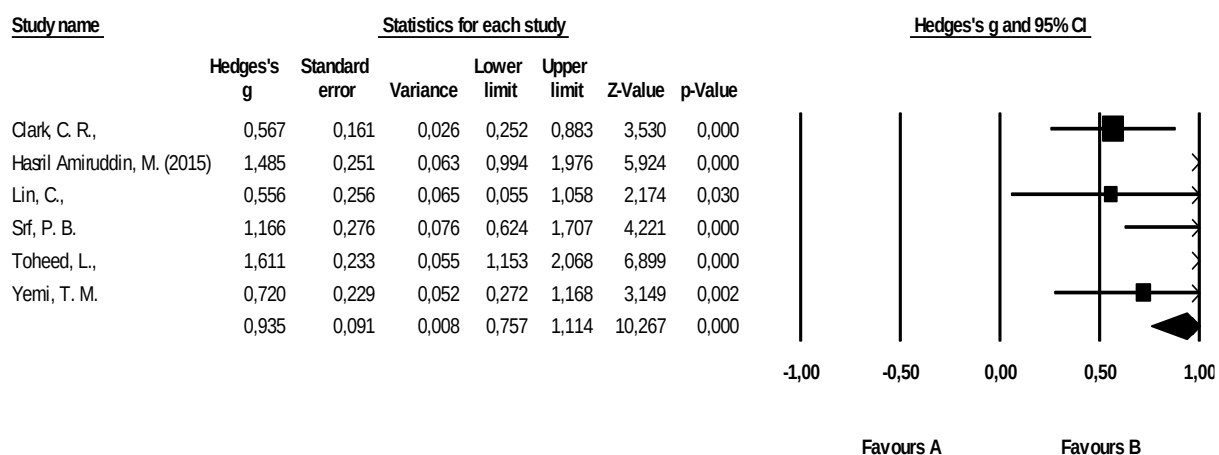


Fig. 2. Forest plot of average effect sizes

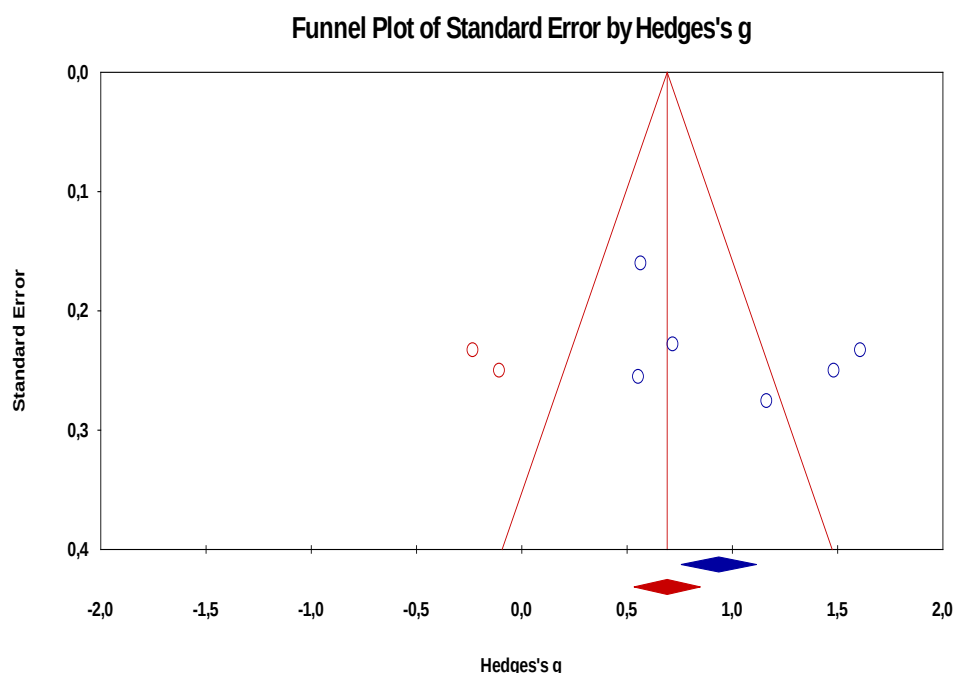


Fig. 3. Funnel plot of publication bias

6. LIMITATIONS

The present meta-analysis has several limitations. First, we analyzed a limited number of studies which aimed at comparing the results of at least two groups: the experimental group where the process was based on mastery learning models, and the control group where the teaching-learning process was a traditional one.

Second, we have chosen a limited number of studies for each educational level: secondary school, high school, and university.

Third, the meta-analysis is focused only on the studies which involved teaching mathematics. This led to the removal of a great number of studies which were based on implementing mastery learning strategies in other subjects.

7. CONCLUSIONS

The current findings suggest that applying mastery learning models leads to improving the students' learning performance. The aim of this meta-analysis was to emphasize the importance of introducing mastery learning strategies in the teaching-learning process and to determine the effectiveness of teaching mathematics for the students who learnt by using these strategies.

This study revealed the fact that mastery learning models lead to better outcomes in learning mathematics and make students more motivated in learning. The analyzed studies emphasize the importance of mastery learning strategies in short-term learning with an immediate effect and in learning retention as well.

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