The Impact of Multiplication Fluency Math Intervention and Attendance on Mathematics Course Performance

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ABSTRACT

Multiplication fluency math interventions are utilized in elementary schools, but a dearth in scholarship exists on the effects of these interventions on fifth grade math students' performance and final grades. This scholarship gap may have an adverse effect on informing administrators and educators on best practices in helping fifth grade math students develop the mathematical skills needed to succeed in the classroom, and developing the necessary competence to translate that success, for employment and income management. My quantitative study examined factors that determine if multiplication fluency math intervention may impact fifth graders on mathematics course performance and end of semester grades. Specifically, this study noted any statistically significant differences in relationships between attendance and final grades. Bandura's Self-Efficacy Theory served as the theoretical framework for this study focusing on student academic assistance such as math intervention program. An archival causal-comparative, between-subjects design is appropriate for the study as observation of probable relationships between groups were observed. Archived data from a school district was utilized for this study. To acquire an appropriate sample size, information from semesters (fall 2017, spring 2018, fall 2018, spring 2019), prior to COVID-19, was aggregated for both groups. A stratified randomized matching procedure assured the treatment and control groups had equal representation. A Mann-Whitney U analysis was utilized for matching mean mathematics grades between groups. Spearman's Rho correlation tested the relationship between two variables, attendance, and end of semester grades. The findings indicated that there was no evidence of a consequential relationship. The treatment group utilizing the intervention did not significantly outperform the control group. A recommendation opportunity for future studies is to track targeted intervention for increased student performance along with examining group intervention versus one-on-one intervention. Implications and recommendations for educational professionals and practitioners were discussed.

Keywords: math intervention, multiplication fluency, mathematics course performance

INTRODUCTION

Mathematics has historically been an area of focus for growth in the education system in the United States (NCES, 2007). Approximately 5% to 10% of school-age youth have mathematical disabilities (Fuchs et al., 2007). Youth with mathematical achievement ranking at or below the 20th to 35th percentile is frequently considered at-risk for diagnosis with learning disabilities or for having learning difficulties in math (Bryant et al., 2011; Fuchs et al., 2007). Statistics from the National Assessment of Educational Progress (NAEP) indicates that not every student meets the criterion for mathematics mastery. For instance, over 80% of fourth graders with disabilities ranked at or below the basic level compared to over 50% without disabilities; over 90% of eighth graders with disabilities compared with over 60% without disabilities ranked at or below the basic level on the 2019 NAEP (National Center for Education Statistics, 2019). There has been growth in intervention research scholarship addressing development of mathematics learning for youth with learning disabilities and who experience math difficulties. Yet, mathematical performance gaps have not lessened as certain factors potentially contributing to this problem (Dossey et al., 2016; Rittle-Johnson & Jordan, 2016). This statement reflects on how an intervention is needed for success and to prepare students for the future.

There are high failing rates for fifth graders learning multiplication fluency (Baker & Cuevas, 2018; Gross & Duhon, 2013). The study was designed to identify relationships among fifth graders' multiplication fluency math intervention and end of semester grades. This quantitative study examined factors that determined if multiplication fluency math intervention will impact fifth graders on mathematics course performance. Mathematics underperformance is of crucial concern with 42% of 4th grade and 36% of 8th grade youth performing at a mastery or complex standard in math and in school are continuously seeking for interventions to enforce with struggling youth (Cheung & Slavin, 2013; Gross & Duhon, 2013; NCES, 2013). Mathematical difficulties have not been the focus of current studies (Salihu & Räsänen, 2018). The current dearth in scholarship may result in an adverse effect impacting high attrition rates, as mathematical skills development is critical for success in the classroom. Additionally, mathematical competence is needed for employment gain, income earned, and success (Rivera-Batiz, 1992). There is presently limited math intervention research that clearly targets the various nature of academic hardships that attempt to determine interventions for both scholarly and intellectual abilities (Koponen et al., 2018). This study was guided by the literature review that describes the key features of mathematical difficulties in elementary school, state-level curriculum for mathematics, multiplication experiences for fifth graders, multiplication fluency scope and sequence, multiplication fluency math intervention, and fifth graders who struggle with mathematics. The foundation for understanding the effect of a mathematics intervention program on students' mathematic performance operates within Bandura's self-efficacy theory (Koponen et al., 2021).

Purpose of the Study

The purpose of the study was designed to determine relationships between fifth grader's multiplication fluency math intervention and end of semester grades. This quantitative study examined factors that determined if multiplication fluency math intervention will impact fifth graders on mathematics course performance. The study utilized an archived causal-comparative, between-subjects design to investigate final grades of a control group and treatment group. In

addition, the relationship amongst attendance and final grades was explored in the treatment group.

Research Questions and Hypotheses

The following were the research questions and hypotheses for the study:

RQ_1: Do fifth grade students who receive a multiplication fluency math intervention significantly outperform fifth grade students not utilizing the multiplication fluency math intervention when measured by mathematics end of semester grades?

H_1: Fifth graders receiving multiplication fluency math intervention will significantly outperform fifth graders not using the multiplication fluency math intervention.

H_0: Fifth graders receiving multiplication fluency math intervention will not significantly outperform fifth graders not using the multiplication fluency math intervention.

RQ_2: For fifth graders in the treatment group, is there a statistically significant relationship among the attendance rates of receiving the multiplication fluency math intervention and mathematics end of semester grades?

H_1: There is a statistically significant relationship among the attendance rates of receiving the multiplication fluency math intervention and math grades for fifth graders in the treatment group.

H_0: There is not a statistically significant relationship among the attendance rates of receiving fluency math intervention and math grades for fifth graders in the treatment group.

To address the first research question, an archived causal comparison, between subject design was utilized to investigate final mathematics grades of fifth graders using the multiplication fluency math intervention (Schenker & Rumrill, 2004). A control group of fifth graders not utilizing the multiplication math intervention was used to conclude if there was a statistically significant disparity in math end of semester grades among those who received math intervention and those who did not. To answer the second question, attendance was examined to conclude if there was a relationship among greater usage of the math intervention and high final grades among the group.

RESEARCH DESIGN AND APPROACH

An archived causal-comparative, between-subjects research design was utilized to address the research questions (Creswell, 2009). Archived mathematics end of semester grades, included frequency of intervention by the participants, from the fall 2017 and 2018, and spring 2018 and 2019, was the data collected from the school district. The semesters chosen for the study supplied an overall adequate sample size for the testing of the research questions. Number of participants was determined based on initial use of the intervention.

To address the research question one, the independent variable examined was the multiplication fluency math intervention utilized by fifth graders for their math course. The dependent variable examined was the individuals' final math grades. Particularly, the first research question was addressed by examining viable disparities, if at all, in grades among the participation group and control group, established on the participation group individual's utilization of the math intervention. Also, the study addressed the second research question examining a relationship among the attendance rate of intervention (independent variable) in the treatment group, and final grades (dependent variable), establishing a statistically significant

relationship, if at all. Additional variables obtained for the purpose of detailing the traits of the sample and establishing the similarity of the participation group and control group, as preexisting disparities among groups provided alternative clarification for the findings.

Setting and Sample

The participants for the study were fifth graders at an elementary school. The treatment group was fifth graders who utilized the multiplication fluency math intervention. The sample involved a control group of fifth graders who did not utilize the multiplication fluency math intervention within the same time frame. As the principal investigator, my study targeted a large enough sample with approximately 60-90 participants in the treatment group. The control campus utilized a database for collecting school enrollment numbers and demographics data. The data was aggregated across four semesters to ensure equal number of representations in the treatment and control groups. Written permission was attained from the district for access to the archived student data associated with this study. More description on sampling and matching methods utilized to build the control group are detailed in the following sections.

A convenience sampling method was utilized due to the convenience of archived data on fifth graders who had participated in a multiplication fluency math intervention. Convenience sampling was utilized due to practical constraints, efficiency, and availability (McMillan & Schumacher, 2010). The sampling procedure was uniformed to the archived causal-comparative research design that was utilized that individual treatment grouping was pre-determined by fifth graders who utilized the intervention. Additionally, the control group contained fifth graders that did not use the intervention. All youth needed to meet equivalent inclusion/exclusion criteria to be involved.

For the purpose of the study, only fifth graders will be the focus of data collection. The control group was chosen utilizing stratified randomized matching method that safeguarded everyone in the participation group was matched with youth from the same semester. Once multiple youth were qualified, one youth was selected at random to ensure sample sizes were equal in the participation group and control group. The matching methods safeguarded an equivalent number of youths were depicted in the participation and control group to rule out the semester as a reason for group disparities.

INSTRUMENTATION

Archival data through the school district captured the descriptive data of the participants utilizing the multiplication fluency math intervention to include student enrollment of mathematics courses and semesters. The data gathered was conducive in the collection of individuals for the treatment group established on the utilization of the intervention. The Public Education Information Management System (PEIMS) data supplied information involving youth demographics and academic achievement and student attendance. The Texas Academic Performance Report (TAPR) is accessible through the Texas Education Agency (2019), where the data is distributed and made accessible to the public each school year. The data provided is by state, district, and school campus disaggregated by student demographics, grade level, ethnicity, and socioeconomic status. TAPR also provides extensive data on school and district staff and programs.

The study investigated obtained archived data of math grades for individual participants of both groups, analyzing averages to establish statistically significant disparities of final grades among groups. For this study, fifth graders who received one-on-one intervention were not distinguished from fifth graders who received group intervention, as the study examined for statistically significant disparities among the participation and control groups as the target. There was not a restriction to the number of time intervention was received for the individuals in the participation group.

RESULTS

The study was designed to determine relationships among fifth graders' multiplication fluency math intervention and end of semester grades. This quantitative study examined factors that determined if multiplication fluency math intervention impacted fifth graders on mathematics course performance. The study utilized an archival causal-comparative, between-subjects design examining grades of a treatment group and control group. In addition, the relationship among attendance and grades in the treatment group was explored. In this section, descriptive statistics and examination for preexisting group disparities are detailed.

For pre-existing differences, crosstabulation findings indicated no statistically significant difference found with gender and grades, $r_s(.125) = -.467$, $p = .642$. Crosstabulation findings also indicated no statistically significant difference established with race/ethnicity and grades, $r_s(.106) = 1.873$, $p = .066$. Mann-Whitney U findings indicated a statistically significant difference in grade division among the treatment and comparison groups thus, the null hypothesis could not be rejected (Mann-Whitney U = 281.0, $_{n1} = 31$, $_{n2} = 31$, p = .002, two-tailed $r = .48$). The control group had a greater mean rank average in grades (37.94) than the treatment group (25.06). Spearman's Rho findings indicated no statistically significant difference was found between the frequency of use of the intervention and treatment group participant end of semester grades (rho= .573, $p= .002$).

Descriptive Analysis

Descriptive statistics were reported for: end of semester grades and frequency of intervention. Table 1 reports the participation demographic data between groups. The table demonstrates the stratified randomized matching method utilized to safeguard each individual in the treatment group was paired with students from the control group. There were an equal number of males (32%) and females (68%) within both groups. With the race/ethnicity variable, the students were matched as close as possible: Treatment group, White (0%), Hispanic (74%), African American (26%), Asian (0%), and Other (0%); Control group, White (7%), Hispanic (77%), African American (16%), Asian (0%), and Other (0%).

Table 1
Subject Data

Trait	Control (n = 31)	Participation (n = 31)	Total (n = 62)
Gender			
Male	21 (68%)	21 (68%)	42
Female	10 (32%)	10 (32%)	20
Total	31	31	62
Ethnicity			
White	2 (7%)	0	2
Hispanic	24 (77%)	23 (74%)	47
African American	5 (16%)	8 (26%)	13
Asian	0	0	0
Other	0	0	0
Total	31	31	62

The following data was retrieved from the school district for all individuals in the study: Race/ethnicity, designated as nominal data and coded: White (1), Hispanic/Latino (2), African American (3), Asian (4), and Other (5). Gender was designated as nominal data and coded as Male (1) and Female (0). Variables quantified in the study included end of semester grades (ordinal data) with math letter grades assigned a code: A (4); B (3); C (2); D (1); and F (0); and frequency of intervention. See Table 2 below for an exhaustive list of variables utilized in the study. The table shows the complete list of variables and coding used in the dataset. All the variables needed to be coded to be input correctly into the SPSS software.

Table 2
List of Variables

Variable	Code	Data
Demographic Variables		
Gender		Nominal
Female	0	
Male	1	
Race/Ethnicity		Nominal
White	1	
Latino/Hispanic	2	
African American	3	
Asian	4	
Other	5	
Independent Variables		
Intervention		Nominal
Control	0	
Treatment	1	
Frequency of Intervention	Whole Numbers	Ratio
Dependent Variables		
Grades		Ordinal
A	4	

B	3
C	2
D	1
F	0

Table 3 details grade division for the whole sample and Table 4 details grade division individually for both groups. For both groups ($N = 62$), the grade mean, median, and standard deviation were ($M = 2.79$, $Md = 2.00$, $SD = .750$), and for both groups by frequency and grades follows.

Table 3

Frequency/Percent of Both Groups

Grade	Frequency	Percent
A	12	(20%)
B	25	(40%)
C	25	(40%)
D	0	(0%)
F	0	(0%)
Total	62	100%

Table 4

Frequency and Percent of Both Groups

Grade	Treatment	Control
A	4 (13%)	8 (26%)
B	8 (26%)	17 (55%)
C	19 (61%)	6 (19%)
D	0	0
F	0	0
Total	31	31

Table 5 reports the frequency distribution for the multiplication fluency mathematics intervention. The treatment group data was the only data accessible as control group participants did not utilize the intervention. For the treatment group, the mean, median, and standard deviation were ($M = 21.29$, $Md = 8.00$, $SD = 1.811$).

Table 5

Frequency and Percentage of Treatment Group use of Multiplication Fluency Mathematics Intervention

Frequency	Participants	Percent
23	10	32%
22	5	16%
21	9	29%
20	3	10%
19	2	7%
18	1	3%
15	1	3%
Total: 138	31	100%

To evaluate preexisting disparities among the participation and control groups at baseline, gender and race/ethnicity were utilized to test for any disparities among the groups. The aim was to safeguard that if disparities were established, it was not due to gender and race/ethnicity. Crosstabulation findings indicated no significant relationship found with gender and grades, $r_s(.125) = -.467$, $p = .642$. Crosstabulation findings also indicated no significant relationship established with race/ethnicity and grades, $r_s(.106) = 1.873$, $p = .066$. The findings conclude the participation and control group were not significantly disparate concerning race/ethnicity and gender in promoting efficiency of the utilization of stratified randomized matching method to build the control group.

To prepare to run a Mann-Whitney U test for grades among both groups, the assumptions of the analysis were tested to ensure all data for each group are independent; and dependent variables are continuous, or ordinal were met (Morgan et al., 2020). To prepare to run Spearman's Rho correlation from the dataset for the participation group to address the second research question, the two assumptions tested were data for both variables were ordinal, and there is a monotonic connection among two variables. Investigation of the scatterplot among grades and frequency of intervention implied a monotonic connection among the variables, indicating second assumption was met.

The following questions guided this study:

RQ_1: Do fifth grade students who receive a multiplication fluency math intervention significantly outperform fifth grade students not utilizing the multiplication fluency math intervention when measured by mathematics end of semester grades?

RQ_2: For fifth graders in the treatment group, is there a statistically significant relationship among the attendance rates of receiving the multiplication fluency math intervention and mathematics end of semester grades?

Research Question 1

To address the first research question multiplication fluency mathematics intervention effect on final grades, a Mann-Whitney U test, a nonparametric test, was chosen to examine grade division among both groups. Mann-Whitney U examines mean ranks which are the arithmetic average of ordering the data by rank for both groups to establish statistical significance. For grade division, greater mean ranks imply greater grades and lesser mean ranks imply lesser grades. The Mann-Whitney U test findings does indicate a statistically significant difference in grade divisions among the participation and control group in which the null hypothesis would be rejected, however, there is not enough evidence to identify a consequential relationship; thus, the null hypothesis failed to be rejected (Mann-Whitney U = 281.0, $n1 = 31$, $n2 = 31$, p = .002, two-tailed $r = .48$). With the control group having a greater mean rank in grades (37.94) in comparison with the treatment group (25.06), the findings implied no significant difference between the control group having higher grades than the treatment group (See Table 6). The disparity disclosed a medium effect size of $r = 0.48$ (Morgan et al., 2020).

Table 6

Mann-Whitney U Findings

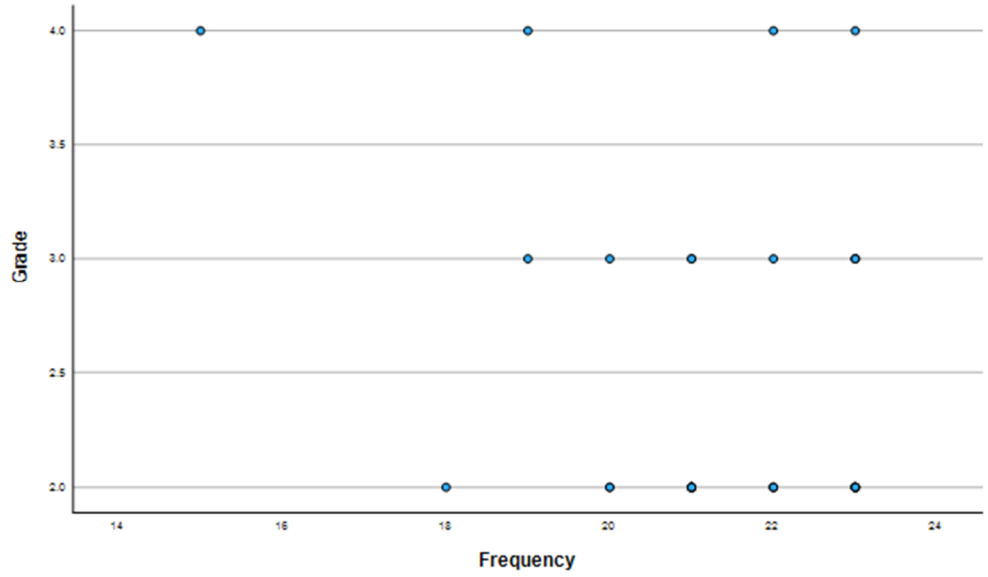
Group		N	Mean Rank	Sum
Grade:	0	31	37.94	1176.00
	1	31	25.06	777.00
Sig. (2-tailed)		.002		

Research Question 2

To address the second research question, Spearman's Rho measured the frequency of intervention and final grades in the participation group. Thirty-one individuals' archival data were detected for frequency of intervention (M = 21.29, SD = 1.811) and final grades (M = 2.52, SD = .724). Figure 1 displays the scatterplot among frequency of intervention and final grades. Spearman's Rho investigation disclosed no relationship (rho= .573, p= .002) among frequency of intervention and final grades in the participation group. The scatterplot shows no correlation found between frequency of intervention and grades within the treatment group. There was not an indication of a positive or negative correlation according to the scatterplot. The grades did not increase or decrease dependent on the frequency of intervention.

Figure 1

Scatterplot between frequency of intervention and final grades within treatment group.



Summary of the Results

To investigate the first research question:

RQ_1: Do fifth grade students who receive a multiplication fluency math intervention significantly outperform fifth grade students not utilizing the multiplication fluency math intervention when measured by mathematics end of semester grades?

A control group of youth was created who did not participate in the intervention. A matching procedure was utilized to ensure that no disparities exist among the treatment and control group regarding race/ethnicity and gender. Nonetheless, individuals were randomly chosen for involvement in the control group, thus disparities on other probable misleading

factors could be lessened. Initial findings established the groups were not significantly disparate on race/ethnicity and gender assuring all disparities were proven.

The findings of the first research question indicated a statistically significant disparity in grade divisions among the groups, however, there was no evidence of a consequential relationship. Therefore, the study failed to reject the null hypothesis. Specifically, the participation group utilizing the intervention did not significantly outperform the control group.

The findings of the first research question address Bandura's self-efficacy theory for the treatment and control groups. Specifically, Bandura (2012) defines beliefs that reflect confidence in one's capacity to control motivation, behavior, and social environments. Mathematical success and positive beliefs and self-efficacy toward mathematics are critical for future career options (Rozgonjuk et al., 2020). Anxiety, student attitudes, and self-efficacy are variables that research has designated may affect student learning and academic achievement in mathematics interventions (Czocher et al., 2019; Namkung et al., 2019). Motivation, understanding the importance of school, and home environment can greatly impact student mathematical performance; yet these variables were not quantified in the study.

To investigate the second research question:

RQ_2: For fifth graders in the treatment group, is there a statistically significant relationship among the attendance rates of receiving the multiplication fluency math intervention and mathematics end of semester grades?

The findings of the second research question established there was not a statistically significant relationship among frequency of intervention and final grades for youth in the participation group concluding the results failed to reject the null hypothesis. A probable rationale that the results detected may be the intervention was utilized on an inconsistent basis or the intervention was not utilized long enough to impact grades. Or, as established from the results of the first research question, the intervention simply is not effective. Alternatively, perhaps students who received more intervention had difficulty in class and may have had lower mathematical mastery to begin with.

The findings of the study contrasted with prior research results that demonstrated a statistically significant relationship among frequency of intervention and final grades (Maki et al., 2021). However, the frequency of intervention with the treatment group was not statistically significant. Results for the second research question address Bandura's self-efficacy theory to be able to control one's behavior. Student attitude, a variable not measured in this study, may have been a factor affecting the results of the study. If students did not have time available in their schedule for intervention, they were removed from their elective class to attend the intervention. This can affect self-efficacy and motivation. Self-esteem can be affected if a student is removed from their mainstream classroom.

CONCLUSIONS AND RECOMMENDATIONS

The results from this study implied no effect of utilization of the multiplication fluency math intervention on fifth graders' mathematics grades, that is inconsistent to what current literature studies have established (Maki et al., 2021). Future studies with greater sample sizes and matching methods utilizing standards of math achievement are necessary to examine the efficiency of the distinct multiplication fluency math intervention under investigation as well as

intervention programs in general. Furthermore, a stronger understanding of the traits of effective multiplication fluency math intervention programs along with incorporating a growth mindset theory should be examined. Math anxiety in children along with parental attitudes towards mathematics is necessary to determine a link between past achievement and academic achievement.

Results from the study did not assist the efficiency of the intervention. A collaboration among educational professionals in building a more efficient intervention program should be examined. A collaboration between developmental education professionals could help promote the development of more effective intervention programs. Additionally, a researcher and/or practitioner could include continuous research studies and professional development to communicate the ongoing development of intervention programs. Further research of group intervention versus one-on-one intervention should be conducted. A major concern exists in that little is known about the efficiency of multiplication fluency math intervention and which practices might improve them over time (Solheim et al., 2018). This study was designed to help take a first step towards addressing whether multiplication fluency math intervention influences final grades. Continued exploration of interventions is vital to improving success over time.

A deeper recommendation following the examination of the effects of self-efficacy, is to foster a growth mindset of students, educators, and professionals along with interventions and core instruction. Growth mindset is a theory of intelligence that individuals believe that abilities can be acquired through effort and study. The growth mindset theory supports self-esteem, and providing students with praise builds confidence and leads to improved achievement. Focusing on a growth mindset can help students overcome challenges and make progress (School of Education Online, 2022). There has been an increase in elementary youth who suffer from mathematics anxiety (Szczygiel, 2020). Due to the increase of this youth population suffering from anxiety, it is critical for researchers and practitioners to continue studying this population group along with parental attitudes toward mathematics as it is associated with math anxiety among children.

Finally, the target of this study was to answer a crucial nationwide concern facing fifth grade students. I strongly advocate future research on fifth graders' mathematical achievement with a collaboration of educators to determine what variables or factors are barriers affecting fifth graders' scholarly achievement. Race/ethnicity and gender were variables that were controlled for but were beyond the scope of the study. Future studies that examine race/ethnicity, gender, and socioeconomic status are necessary to determine if those variables impact intervention. It is imperative that despite efforts to deepen the rigor of mathematics lessons, mathematics performance gaps must decrease, and developmental educators and professionals must be qualified in meeting the demands of this youth population by promoting efficient intervention programs cognizant on steadfast educational theories demonstrated in application by promoting efficient approaches conducive to student scholarly success.

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