Mathseeds (2021-22)

Study Type: ESSA Evidence Level II

Prepared for:
3P Learning

Prepared by LearnPlatform:
Meetal Shah, Ph.D., Senior Researcher, LearnPlatform
Alexandra Lee, Ph.D., Researcher, LearnPlatform

May 26, 2023

EXECUTIVE SUMMARY

3P Learning contracted with LearnPlatform by Instructure, a third-party edtech research company, to examine the relationship between usage of Mathseeds and student math achievement. LearnPlatform designed the study to satisfy Level II requirements (Moderate Evidence) according to the Every Student Succeeds Act (ESSA).

Study Sample, Measures, and Methods

This study occurred during the 2021-22 school year and included 1,764 K – 2 students and 705 Grade 3 students from ten elementary schools in one district. The K – 2 sample comprised mostly of users of Mathseeds, however, the Grade 3 sample comprised of 605 students who used Mathseeds and 100 students who did not use Mathseeds.

Researchers used two measures to provide insights into Mathseeds implementation and evidence about potential impacts of Mathseeds on student learning outcomes: Mathseeds usage and NWEA MAP® scaled scores for mathematics.

Researchers used a variety of quantitative analytic approaches to answer the research questions. First, researchers used descriptive statistics to examine participant characteristics and support implementation analyses. Researchers then conducted linear regressions to examine how Mathseeds use related to student math outcomes from fall 2021 to spring 2022. The analyses included student-level covariates to control for potential selection bias. Researchers also used linear regression analysis to examine whether there were any differences between Grade 3 students who used Mathseeds during the 2021–22 school year and a matched sample of students who did not use the program. In addition, researchers calculated standardized effect sizes (Hedge's g) to determine the magnitude of changes in student outcomes.

Student Outcomes

- K – 2 students who completed between 35–110 total lessons (high use) in Mathseeds had higher end-of-year NWEA MAP® achievement compared to students who completed between 0–13 total lessons (low use).
- Grade 1 students who completed more Mathseeds lessons had statistically significantly higher end-of-year math achievement. This relationship was trending for kindergarten students and not statistically significant for Grade 2 students.
- Grade 3 students who used Mathseeds had slightly higher scores on NWEA MAP® at the end of the year than Grade 3 students who did not use the program (effect size = 0.14).

Conclusions

This study provides results to satisfy ESSA evidence requirements for Level II (Moderate Evidence) given the study design and positive, statistically significant findings for Grade 3 students.

TABLE OF CONTENTS

Introduction

3P Learning recognizes that educators are often responsible for meeting the learning needs of K – 3 students with increasingly diverse prior math knowledge, skills, and attitudes towards the subject. The time demand on teachers is exacerbated when early elementary students perform poorly on math assessments and develop math anxiety. Since early math skills are a strong predictor for later achievement in math, it is important for educators to support young students in developing positive attitudes towards math through high quality, personalized instruction. This can be challenging for elementary educators given limited time and resources. The Mathseeds program provides a comprehensive and motivational online math curriculum for K – 3 students with lessons that foster a positive problem-solving attitude towards math. It draws on the following principles of effective mathematical pedagogy and instruction: building on students' thinking; making connections; motivation, engagement, and feedback; structured lessons with multiple representations and tools; and assessment for learning.

As part of their ongoing efforts to demonstrate the efficacy of Mathseeds, 3P Learning contracted with LearnPlatform, a third-party edtech research company, to examine the relationship between usage of Mathseeds and student achievement. After co-developing an updated logic model (see Appendix A) for Mathseeds (Shah & Henschel, 2022), LearnPlatform designed the study to satisfy Level II requirements (Moderate Evidence) according to ESSA. Implementation of the Mathseeds program among K – 2 students was robust and as such did not yield a large enough comparison sample of non-users however, the Grade 3 sample had a sufficient comparison sample of non-users.

The current study had the following research questions to satisfy Level II requirements (Moderate Evidence) according to ESSA:

Program Implementation Research Questions

1. Overall, how many Mathseeds lessons were completed by students during the 2021–22 school year?
2. Among Mathseeds users, what were the usage patterns?

Effectiveness Research Questions

After controlling for students' prior math achievement, gender, race, and grade,

3. How were different Mathseeds usage patterns related to students' spring 2022 math achievement?
    a. Which usage pattern(s) of Mathseeds had the greatest impact on students' spring 2022 math achievement?
4. What was the overall impact of Mathseeds on students' spring 2022 math achievement in Grade 3?

Methods

This section of the report briefly describes the setting, participants, measures, and analysis methods.

Setting

The study included one district in Southeastern US and an analysis sample of K – 3 students across ten schools.

Participants

There were 2,469 students in the final analytic sample. According to demographic data provided by the district, the racial breakdown of students in the sample was as follows: White (59%), African American (23%), Hispanic (9%), and multi-racial (8%). Females made up 48% of the group, while males accounted for 52%. In addition, the percentages of students enrolled in each of the grades was as follows: kindergarten (16%), first grade (26%), second grade (29%), and third grade (29%).

Measures

This study included the following measures to provide insights into Mathseeds implementation and evidence about the potential impacts of Mathseeds on student achievement.

Mathseeds Usage Metrics. Researchers utilized 2021-22 student-level usage (i.e., total lessons completed). These usage data informed the extent to which students used Mathseeds during the school year and whether students' use of Mathseeds related to learning outcomes on NWEA MAP® Mathematics.

NWEA MAP® Mathematics Scores. NWEA MAP® RIT scales are stable, equal interval scales that use individual item difficulty values to measure student achievement independent of grade level. The scores are vertically scaled so that student scores can be compared over time and across grade levels. The RIT scale ranges from 100–350. Researchers used the RIT scale score as an overall measure of math achievement at two time points: pretest (i.e., fall 2021) and posttest (i.e., spring 2022).

Data Analysis

Researchers used a variety of quantitative analytic approaches. First, researchers conducted descriptive statistics to describe participant characteristics and support implementation analyses. Researchers then conducted linear regressions to examine how Mathseeds use related to K – 3 student math outcomes from beginning- to end-of-year. The analyses included student-level covariates to control for potential selection bias. Researchers also examined whether there were any differences in achievement between Grade 3 students who used Mathseeds during the 2021–22 school year and students who did not use the program using linear regression analysis. In addition, researchers calculated standardized effect sizes to determine the magnitude of changes in student outcomes or the standardized difference between student groups' math outcomes.

Baseline Equivalence

To ensure the validity of the study's findings and to adhere to What Works Clearinghouse's quasi-experimental study standards, the researchers assessed the equivalence of Grade 3 students' beginning-of-year assessment scores and demographic characteristics (i.e., gender and race), between student usage groups (i.e., students who used Mathseeds and students who did not use Mathseeds). For Grade 3 students, baseline differences for beginning-of-year assessment scores, were not significant, however, researchers included beginning-of-year assessment scores in the final model. See Appendix B for more details regarding baseline equivalence.

Program Implementation Findings

The charts below highlight Mathseeds use during the 2021-22 school year based on 3P Learning's internal usage data (Table 1). Overall, K – 3 users completed an average of 15 Mathseeds lessons (SD = 16) in total.

Table 1: Average Mathseeds Usage by Grade

	K	Gr 1	Gr 2	Gr 3
Number of Mathseeds users	405	654	705	605
Average Mathseeds lessons completed	21	18	13	13

Researchers conducted a *k*-means cluster analysis to group students by similar levels of Mathseeds usage based on the number of total lessons completed.

For total lessons completed, K – 2 students fell into three usage categories ranging from low usage (mean = 6, range = 0–13 total lessons), to moderate usage (mean = 22, range =14–34 total lessons), and high usage (mean = 48, range = 35–110 total lessons; Figure 1).

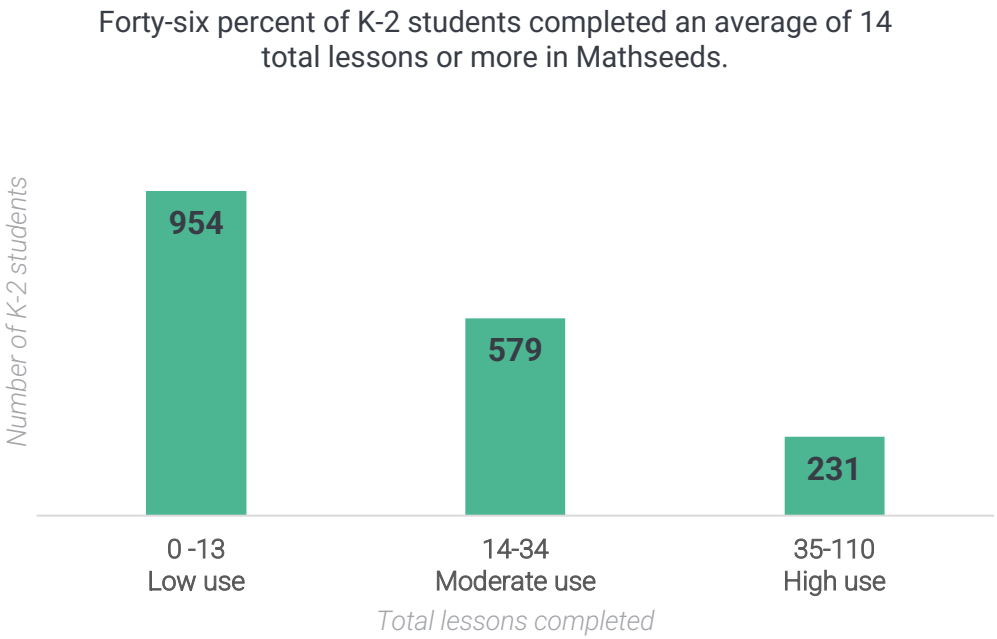


Figure 1. Overall distribution of total lessons completed in Mathseeds by K – 2 students.

For total lessons completed, Grade 3 students fell into three usage categories ranging from low usage (mean = 5, range = 1–11 total lessons), to moderate usage (mean = 19, range =12–32 total lessons), and high usage (mean = 46, range = 33–153 total lessons) (Figure 2).

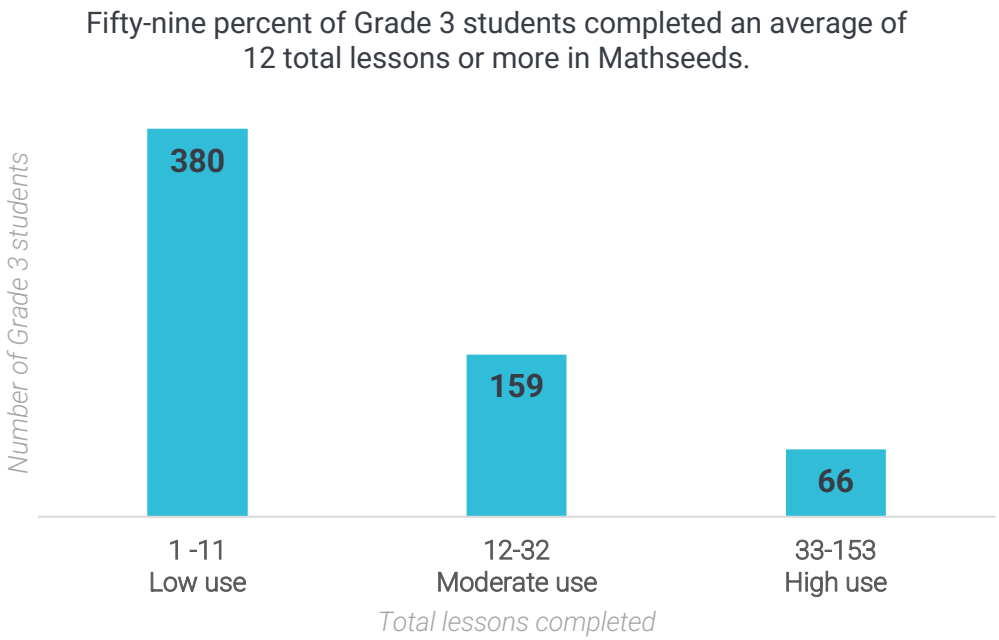


Figure 2. Overall distribution of total lessons completed in Mathseeds by Grade 3 students.

Student Findings

Researchers examined whether greater usage of Mathseeds related to higher end-of-year NWEA MAP® mathematics achievement using regression models that included beginning-of-year NWEA MAP® achievement, gender, race, and grade as covariates. This relationship was first investigated with the overall K – 2 sample and then individually, for each grade. To allow for better interpretability of results, marginal means charts are presented below. The orange vertical lines at the top of each bar represent a 95% confidence interval (see Appendix C for more details about the model and the corresponding Hedge's g effect sizes).

Overall Relationship Between Total Lessons Completed and K – 2 Students' Math Achievement on NWEA MAP®

Key Finding 1. Overall, K – 2 students who completed between 35–110 total lessons (high use) in Mathseeds had higher end-of-year NWEA MAP® achievement compared to students who completed between 0–13 total lessons (low use; effect size 0.08) (Figure 3).

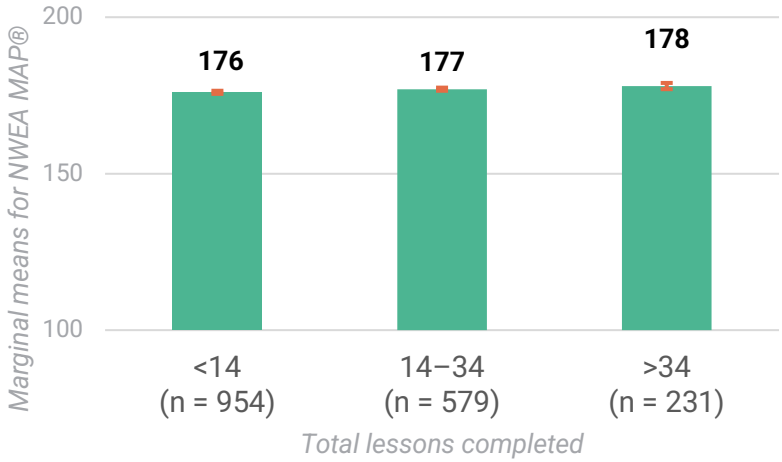


Figure 3. Marginal means for NWEA MAP® for K – 2 Mathseeds users (*n* = 1,764) by usage group.

Relationship Between Total Lessons and K – 2 Students' Math Achievement on NWEA MAP® by Grade

Researchers examined whether greater usage of Mathseeds related to higher end-of-year NWEA MAP® math achievement for each grade. Each linear regression model included NWEA MAP® scores, gender, and race as covariates.

Key Finding 2. Kindergarten students who completed between more than 35 total lessons (high use) in Mathseeds had higher end-of-year NWEA MAP® achievement compared to students who completed fewer than 14 total lessons (low use; effect size 0.16). This result was trending positive (p = .08). The results for other usage groups were positive but not statistically significant. Specifically, kindergarten students' math achievement was approximately equivalent across these usage groups (Figure 4).

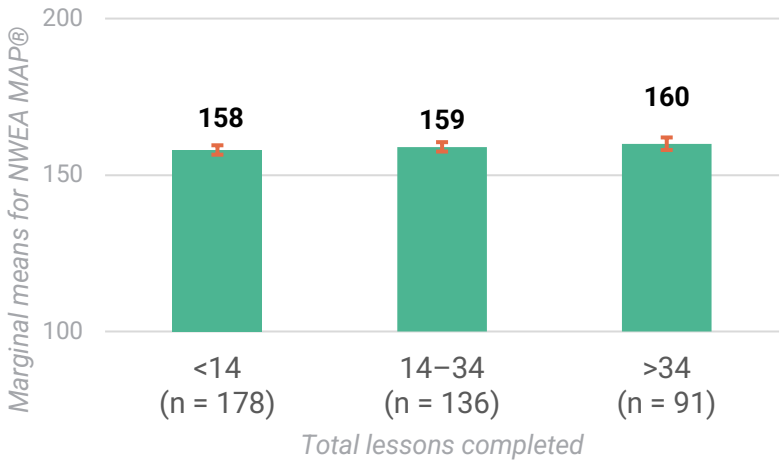


Figure 4. Marginal means for NWEA MAP® for kindergarten Mathseeds users (n = 405) by usage group

Key Finding 3. There was one statistically significant relationship for Grade 1 students, such that students who completed more Mathseeds total lessons had higher end-of-year NWEA MAP® achievement. Specifically, Grade 1 students who completed between more than 34 total lessons (high use) in Mathseeds had higher end-of-year NWEA MAP® achievement compared to students who completed fewer than 14 total lessons (low use; effect size 0.16) (Figure 5).

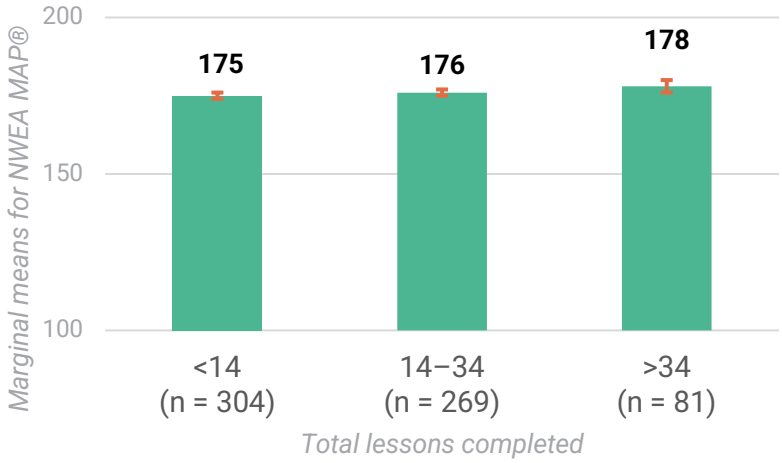


Figure 5. Marginal means for NWEA MAP® for Grade 1 Mathseeds users (n = 654) by usage group

For Grade 2 students, the results were positive but not statistically significant. Specifically, Grade 2 students' achievement was approximately equivalent across all the usage groups (Figure 6).

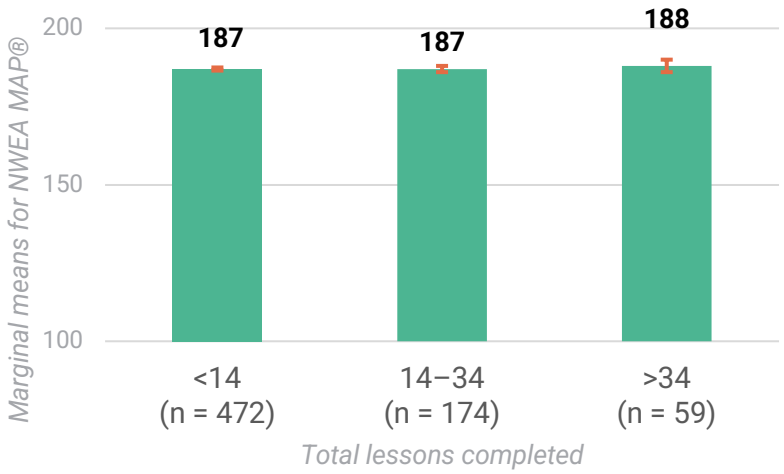


Figure 6. Marginal means for NWEA MAP® for Grade 2 Mathseeds users (*n* = 705) by usage group

Overall Relationship Between Total Lessons Completed and Grade 3 Students' Math Achievement on NWEA MAP®

For Grade 3 users, the results were not statistically significant. Specifically, Grade 3 students' achievement was approximately equivalent across all the usage groups (Figure 7).

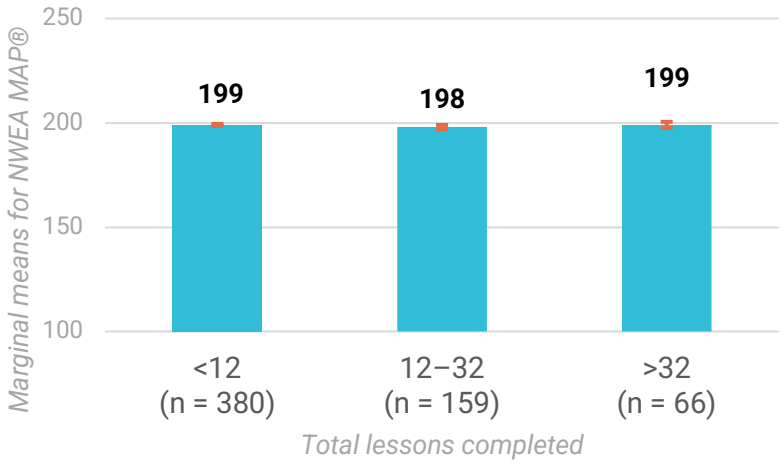


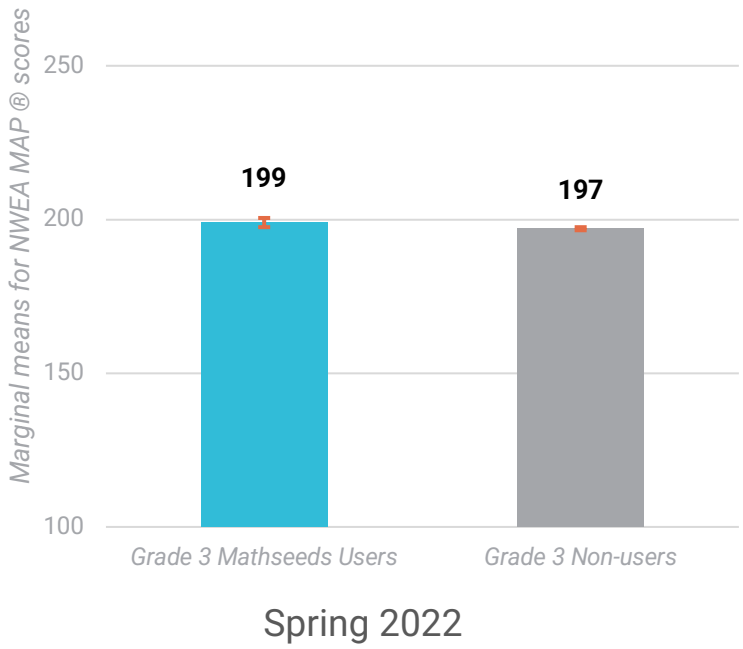
Figure 7. Marginal means for NWEA MAP® for Grade 3 Mathseeds users (*n* = 605) by usage group

Differences Between Grade 3 Students who used Mathseeds and Grade 3 Students Who Did Not Use the Program at the End of the Year

Finally, researchers conducted linear regression analysis with propensity score weighting and NWEA MAP® end-of-the-year scores as the outcome of interest to examine any differences between

students who used Mathseeds and students who did not use the program while controlling for NWEA MAP® beginning-of-year scores. Results at the end-of-the-year show that students who used Mathseeds scored statistically significantly higher on end-of-the-year NWEA MAP® than students who did not use the program (see Key Finding 4).

Key Finding 4. Grade 3 students who used Mathseeds had slightly higher scores on NWEA MAP® at the end of the year than Grade 3 students who did not use the program (effect size = 0.14).



Note: The orange vertical lines at the top of each bar represent a 95% confidence interval.

Conclusions and Recommendations

In sum, the findings support a relationship between Mathseeds usage and improved math skills for K – 2 students. Furthermore, for Grade 3 students, students who used Mathseeds scored statistically significantly higher on the end-of-the-year NWEA MAP® assessment than students who did not use the program. Given the set of positive outcome findings, this study provides results to satisfy ESSA evidence requirements for Level II (Moderate Evidence). Specifically, this study met the following criteria for Level II:

✔ Comparative design

✔ Proper design and implementation

✔ Statistical controls through covariates

✔ At least one statistically significant, positive finding

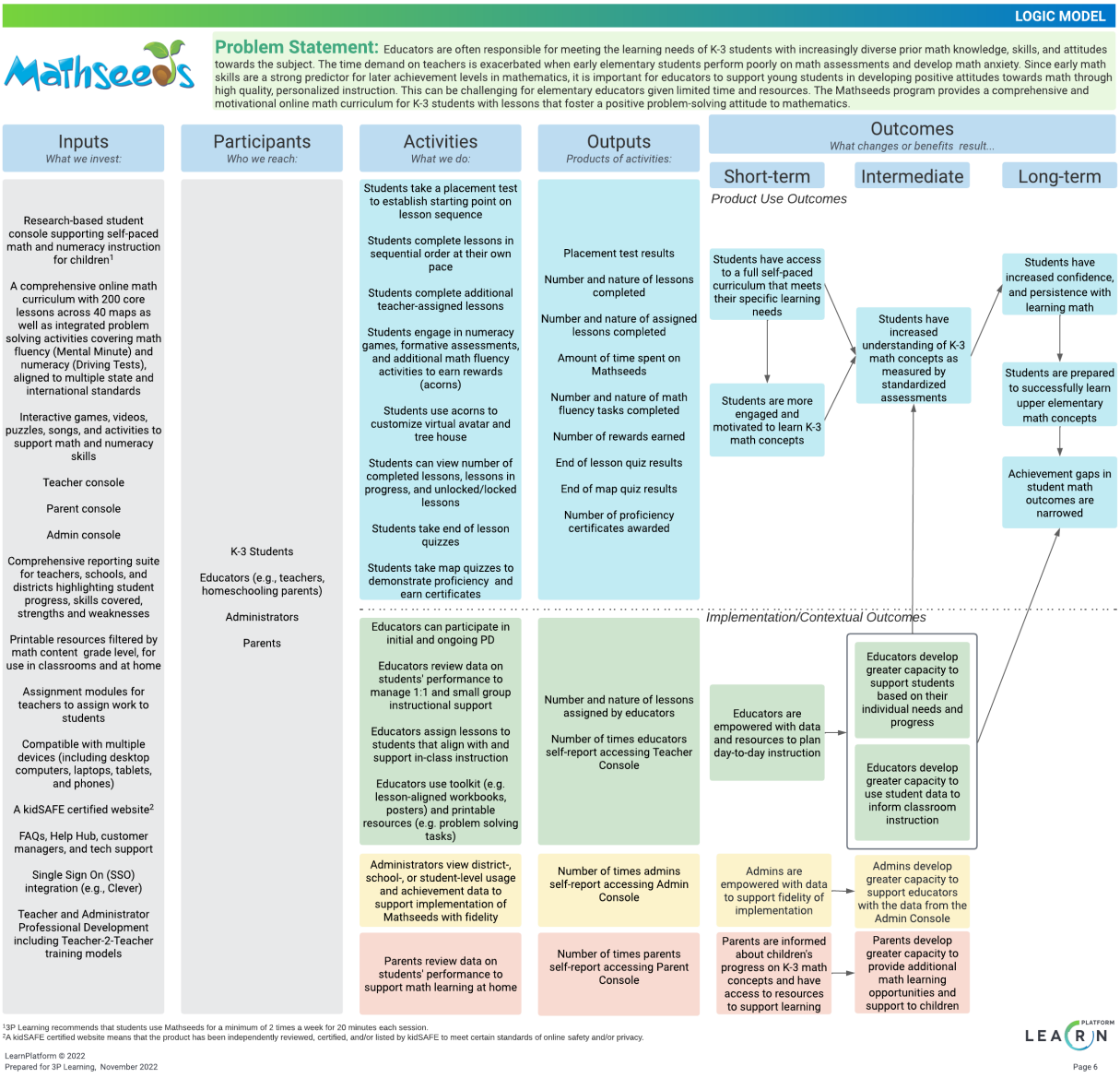
Researchers recommend the following next steps:

- K – 2 students who completed at least 35 total lessons had higher scores on the end-of-year NWEA MAP® assessment. 3P Learning should continue to explore ideal implementation at other sites using this baseline information.
- Given the positive findings from the comparative study among Grade 3 students, 3P Learning should consider recruiting a district that has a sufficient number of K – 2 non-users to better understand how math achievement for K – 2 students who use Mathseeds compares to that of students using other math programs in those grades.

Acknowledgements

The authors would like to extend their deepest thanks to Ben Chalmers who supported the preparation of data for this report.

Appendix A. Mathseeds Logic Model



Appendix B. Additional Information on Study Design and Methods

Propensity Score Weighting

To help make the student groups (i.e., students who used Mathseeds and students who did not use Mathseeds) as comparable as possible, propensity score weights were calculated for each student. To calculate propensity scores, researchers conducted binary logistic regression with student group as the dependent variable and grade, gender, and NWEA MAP® beginning-of-year scores as the covariates. The probability was saved as a new variable. Weights were calculated by dividing one by the probability (one/probability). Students without a weight were dropped from the final analytic sample. All analyses that included students who did not use Mathseeds included these weights.

Baseline Equivalence

Researchers conducted baseline equivalence analyses to determine whether there were baseline differences in characteristics between students who used Mathseeds and students who did not use the program during the 2021–22 school year. Specifically, researchers used chi-square analyses on student-level demographics and linear regressions on beginning-of-year scores. As noted in Table B1, there were no statistically significant differences between groups regarding gender and race.

Table B1. Baseline Equivalence Analysis of Grade 3 Student-Level Demographics by User Group

Characteristics	Users (*n* = 605)		Non-users (*n* =100)		Chi-squared	*p*-Value	Effect Size
	Percent	*N*	Percent	*N*			
Gender							
Male	54	327	50	50	0.57	.452	0.03
Female	46	278	50	50			
Race							
Black	23	137	26	26	1.94	.857	0.05
Hispanic	8	49	8	8			
Multi-race	8	48	9	9			
White	61	368	56	56			

+ $p<0.1$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$

As noted in Table B2, results from the weighted regression analysis reveal that there was a no statistically significant difference between student groups, indicating that researchers did not need to include MAP NWEA® beginning-of-year math achievement in the model.[1]

Table B2. Baseline Equivalence Analysis of MAP NWEA® Beginning-of-Year Math Scores

Outcome Variable	Coefficient	Standard Error	t-value	*p*-value
MAP NWEA® beginning-of-year math achievement	-0.45	1.46	-0.31	.754

[1]Researchers controlled for beginning-of-year math achievement even though groups were statistically similar at baseline.

Appendix C. Additional Information on Outcome Findings

Table C1. NWEA MAP® unadjusted, raw means by Grade for Fall 2021 and Spring 2022

Sample	*N*	Fall 2021 Mean	SD	Spring 2022 Mean	SD
Overall K – 2	1,764	161	18	176	18
Kindergarten	405	141	11	159	13
Grade 1	654	161	13	176	14
Grade 2	705	174	14	187	14
Grade 3 Users	605	187	13	199	14
Grade 3 Non-users	100	187	13	197	14

Overall Relationship Between Total Lessons and Grades K-2 Students' Math Achievement on NWEA MAP®

Table C2. Grades K-2 Students' Math Achievement on NWEA MAP® by Total Lessons on Mathseeds (covariates: beginning-of-year NWEA MAP® achievement, gender, and race)

Group Comparisons	Coefficient	Standard Error	*t*-value	*p*-value	Effect Size
0–13 total lessons compared to 14–34 total lessons	0.54	0.44	1.23	.22	0.03
0–13 total lessons compared to 35–110 total lessons	1.53	0.62	2.49	.01*	0.08
14–34 total lessons compared to 35–110 total lessons	0.99	0.65	1.52	.13	0.06

Relationship Between Total Lessons and K – 2 Students' Math Achievement on NWEA MAP® by Grade

Table C3. Kindergarten Students' Math Achievement on NWEA MAP® by Total Lessons on Mathseeds (covariates: beginning-of-year NWEA MAP® achievement, gender, and race)

Kindergarten Group Comparisons	Coefficient	Standard Error	*t*-value	*p*>|*t*|	Effect Size
0–13 total lessons compared to 14–34 total lessons	1.09	0.99	1.1	.27	0.08
0–13 total lessons compared to 35–110 total lessons	2.03	1.15	1.77	.08+	0.16
14–34 total lessons compared to 35–110 total lessons	0.94	1.18	0.8	.43	0.08

+ $p<0.1$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$

Table C3. Grade 1 Students' Math Achievement on NWEA MAP® by Total Lessons on Mathseeds (covariates: beginning-of-year NWEA MAP® achievement, gender, and race)

Grade1 Group Comparisons	Coefficient	Standard Error	*t*-value	*p*>|*t*|	Effect Size
0–13 total lessons compared to 14–34 total lessons	0.92	0.74	1.24	.22	0.07
0–13 total lessons compared to 35–110 total lessons	2.45	1.09	2.25	.03*	0.16
14–34 total lessons compared to 35–110 total lessons	1.54	1.09	1.41	.16	0.13

+ $p<0.1$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$

Table C4. Grade 2 Students' Math Achievement on NWEA MAP® by Total Lessons on Mathseeds (covariates: beginning-of-year NWEA MAP® achievement, gender, and race)

Grade 2 Group Comparisons	Coefficient	Standard Error	*t*-value	*p*>|*t*|	Effect Size
0–13 total lessons compared to 14–34 total lessons	0.31	0.71	0.43	.67	0.02
0–13 total lessons compared to 35–110 total lessons	0.68	1.11	0.61	.54	0.05
14–34 total lessons compared to 35–110 total lessons	0.37	1.21	0.31	.76	0.03

+ $p<0.1$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$

Overall Relationship Between Total Lessons and Grade 3 Students' Math Achievement on NWEA MAP®

Table C5. Grade 3 Students' Math Achievement on NWEA MAP® by Total Lessons on Mathseeds (covariates: beginning-of-year NWEA MAP® achievement)

Group Comparisons	Coefficient	Standard Error	*t*-value	*p*-value	Effect Size
1–11 total lessons compared to 12–32 total lessons	-0.89	0.68	-1.31	0.19	-0.06
1–11 total lessons compared to 33–153 total lessons	0.18	0.96	0.19	0.85	0.01
12–32 total lessons compared to 33–153 total lessons	1.07	1.05	1.02	0.31	0.07

Difference Between Grade 3 Students who used Mathseeds and Grade 3 Students Who Did Not Use the Program at the End of the Year

Researchers ran a weighted linear regression analysis using propensity score weights in the model to examine whether there were differences between students who used Mathseeds and students who did not use the program. In addition to the outcome of interest (i.e., end-of-year NWEA MAP® scores),

the model included the student group, propensity score weights, and beginning-of-year NWEA MAP® scores (Table C4).

Table C6. Differences between NWEA MAP® End-of-the-Year Scores by Student Group

Group Comparisons	Coefficient	Standard Error	*t*-value	*p*-value	Effect Size
Students who used Mathseeds Compared to Students who did not use Mathseeds	1.95	0.79	2.45	0.02*	0.14

*Statistically significant at the 0.05 level.