

Frax ESSA Level III Study (2021 - 2022)

Prepared for:
Explore Learning

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EXECUTIVE SUMMARY

Explore Learning contracted with LearnPlatform, a third-party edtech research company, to examine the relationship between student usage of Frax and learning outcomes. LearnPlatform designed the study to satisfy Level III requirements (Promising Evidence) according to the Every Student Succeeds Act.

Study Sample and Measures

This study occurred during the 2021-22 school year and analyses included 658 third and 653 fourth grade students from one school district. Researchers used STAR Math scaled scores as students' math achievement outcome and conducted descriptive statistics, paired t-tests, and partial correlations. Researchers examined Frax usage data and relationships between Frax usage and student outcomes. Frax tends to be used with a companion learning solution called Reflex, therefore, to understand the effects of both solutions, researchers included Reflex usage data in the study.

Findings

Student usage. Overall, students completed an average of 9.7 Frax missions¹ and spent an average of 76.6 active days in Reflex. Grade 3 students completed an average of 8.5 Frax missions and spent an average of 73.6 active days in Reflex. Meanwhile, Grade 4 students completed an average of 10.9 Frax missions and spent an average of 80.5 active days in Reflex. On average, Grade 4 students completed more Frax missions and had more active days on Reflex than Grade 3 students.

Student outcomes. Researchers conducted partial correlations to examine the relationship between Frax usage and math achievement while controlling for grade, Reflex use, and fall STAR Math achievement results. After accounting for grade, Reflex use, and fall STAR Math achievement results, students who completed more missions in Frax, had higher math achievement ($r = 0.13$) at the end of the study and this relationship was statistically significant.

Conclusions

This study provides results to satisfy ESSA evidence requirements for Level III (Promising Evidence) given the study design and positive, statistically significant findings.

¹ While Explore Learning recommends that Grade 3 students complete all 27 Frax missions to gain a full understanding of the Grade 3 fractions content standards, they consider a strong implementation (i.e., recommended dosage) of their product to be between 22-27 Frax missions completed.

ESSA Level III Study Key Takeaways

Frax implementation



Students were moderately engaged with Frax and Reflex



Overall, 33% of students completed 14 or more Frax missions in the school year and 70% of students had between 31 and 121 active days in Reflex



In Grade 3, 16% of students completed 22-27 Frax missions and 65% had over 60 active days in Reflex



In Grade 4, 24% of students completed 22-27 Frax missions and 62% had at least 60 active days in Reflex

Student outcomes



Greater Frax usage was statistically significantly related to more positive spring math achievement (controlling for fall STAR Math achievement, Reflex use, and grade).



Students who completed more missions in Frax had more positive math achievement at the end of the academic year



Grade 3 students who completed more missions in Frax had more positive math achievement at the end of the academic year



Grade 4 students who completed more missions in Frax had more positive math achievement at the end of the academic year



Greater Frax usage was statistically significantly related to more positive spring math achievement for the following student groups (controlling for fall STAR Math achievement, and grade):



Low achieving students



Students on free and reduced priced lunch

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Introduction

Explore Learning contracted with LearnPlatform, a third-party edtech research company, to examine the relationship between usage of Frax and student outcomes. LearnPlatform designed the study to satisfy Level III requirements (Promising Evidence) according to the Every Student Succeeds Act.

Explore Learning recognizes students in the US tend to perform poorly on fractions. Unfortunately, knowledge of fractions at the end of elementary school predicts students' mathematics achievement in high school. Therefore, students who struggle with fractions tend to have difficulties understanding Algebra and are less likely to progress to more advanced mathematics coursework, closing the door to STEM careers. Explore Learning created the Frax learning solution, to address these needs, targeting the earliest fractions content in Grade 3 and providing elementary students with a solid foundation in representing and reasoning about fraction magnitude (see logic model in [Appendix A](#); Shah & Styers, 2022).

The present study had the following research questions:

Implementation Questions

1. How many Frax missions were completed by Grade 3 and 4 Frax students during the 2021–22 school year?
2. Among Frax and Reflex users, what were the usage patterns?

Outcome Questions

3. Controlling for students', prior math achievement, Reflex use, and grade, is greater use of Frax (number of missions completed) related to more positive math achievement among 3rd and 4th grade students?
 - a. What is the nature of the above relationship across all students?
 - b. What is the nature of the above relationship by grade level?
 - c. What is the nature of the above relationship for low achieving students?
 - d. What is the nature of the above relationship by free and reduced lunch (FRL) and English language learner (ELL) status?

This report details the study design and methods, implementation, findings, conclusions, and recommended next steps.

Study Design and Methods

This section of the report briefly describes the study participants, measures, and analysis methods. Additional information on the study design is in [Appendix B](#).

Participants

The treatment-only study sample included 1,311 students from eight schools at one public school district in California. Additional demographic information is available in [Appendix B](#).

Intervention

Frax introduces fractions via a sequence of game-based, standards-aligned learning activities referred to as Frax missions. A student completes a mission by independently solving a series of problems. Altogether, there are 27 missions that span Grade 3 fractions standards. While Explore Learning recommends that Grade 3 students complete all 27 Frax missions to gain a full understanding of the Grade 3 fractions content standards, they consider a strong implementation (i.e., recommended dosage) of their product to be between 22-27 Frax missions completed

Measures



Researchers used STAR Math scaled scores as students' math achievement outcome.

Study Procedures and Timeline

This study occurred during the 2021-22 school year. Students used Frax for the duration of the school year. Frax students completed the STAR Math assessment in fall 2021 and spring 2022. Frax tends to be used with a companion learning solution called Reflex, therefore, to account for the influence of both solutions, researchers included Reflex usage as a covariate.

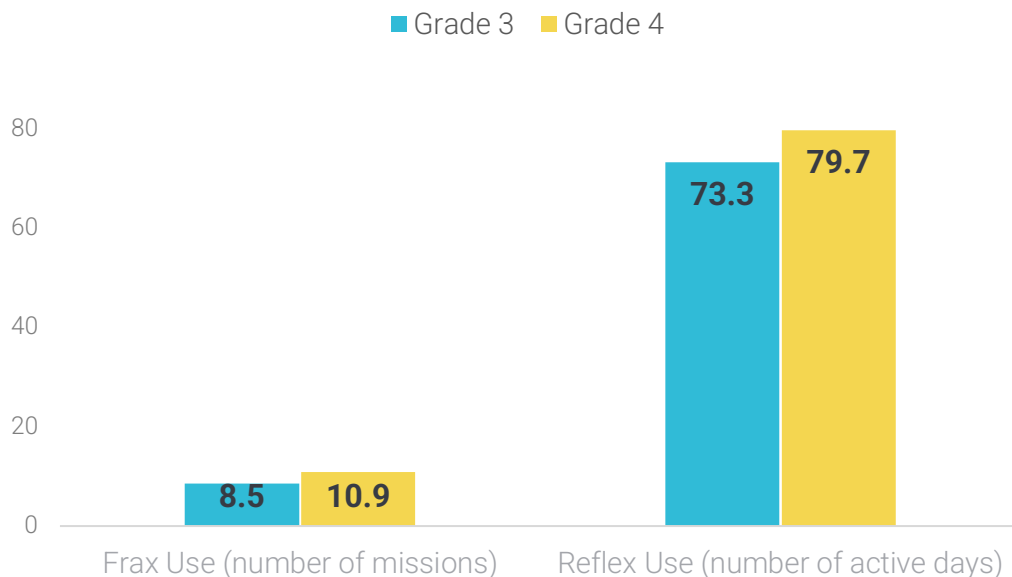
Program Implementation

The charts below highlight Frax and Reflex use during the 2021-22 school year based on Explore Learning's internal usage data. Overall, students completed an average of 9.7 Frax missions (SD = 10.1) and spent an average of 76.6 active days in Reflex (SD = 40.6).

Average Frax and Reflex usage		
		Average Use
	Number of Frax missions completed	9.7 Frax missions
	Number of active days on Reflex	76.6 active days

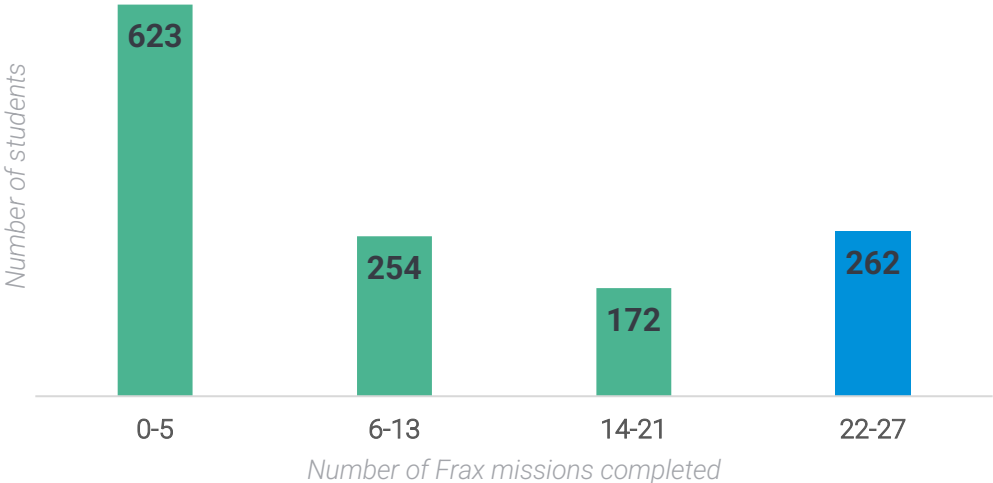
Grade 3 students completed an average of 8.5 Frax missions (SD = 9.6) and spent an average of 73.6 active days in Reflex (SD = 38.8). Grade 4 students completed an average of 10.9 Frax missions (SD = 10.4) and spent an average of 80.5 active days in Reflex (SD = 41.3).

Grade 3 and 4 students had similar levels of Frax use, but Grade 4 students spent slightly more time in Reflex compared to Grade 3.

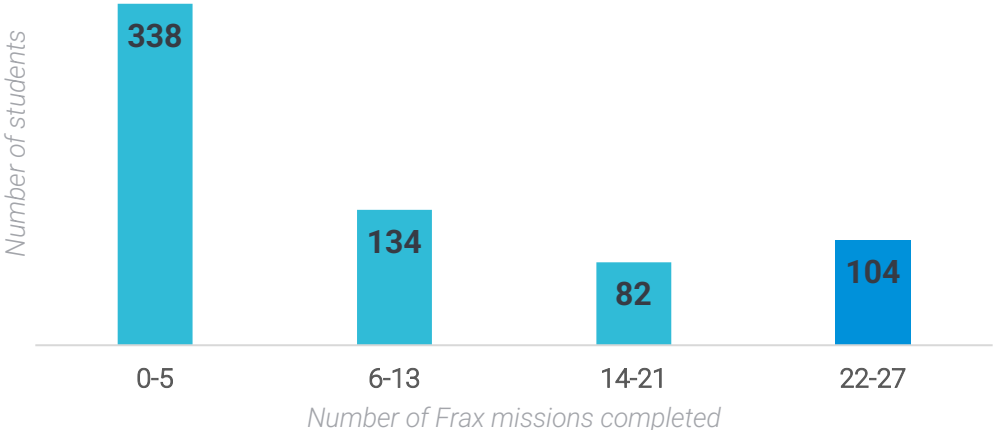


Researchers conducted a *k*-means cluster analysis to group students by similar levels of Frax usage based on their total number of Frax missions completed in the 2021-22 school year. Overall, students fell into four usage categories ranging from very low usage (0-5 missions), low usage (6-13 missions), high usage (14-21 missions), and very high usage (22-27 missions). The graphs that follow depict Frax usage groups overall and by grade level.

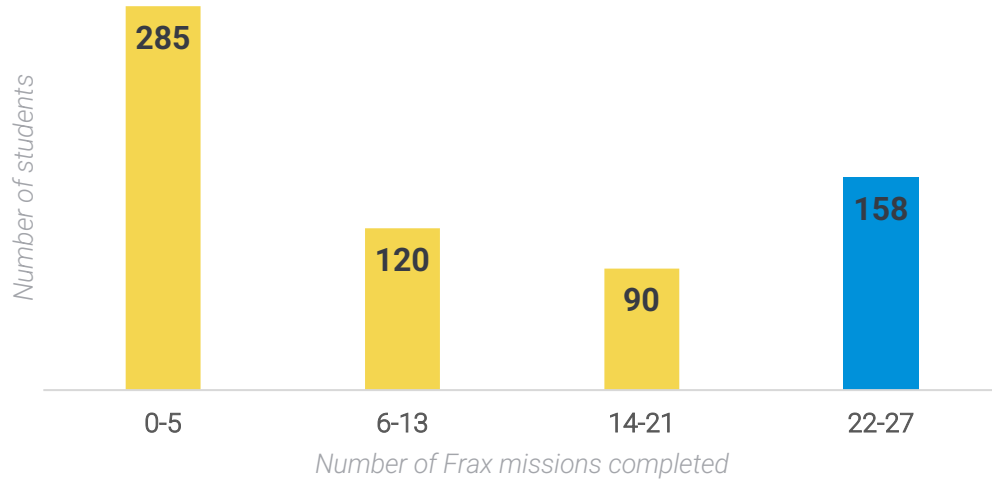
33% of students completed 14 or more Frax missions and 20% completed the recommended dosage of 22-27 Frax missions.



28% of Grade 3 students completed 14 or more Frax missions and 16% completed the recommended dosage of 22-27 Frax missions.

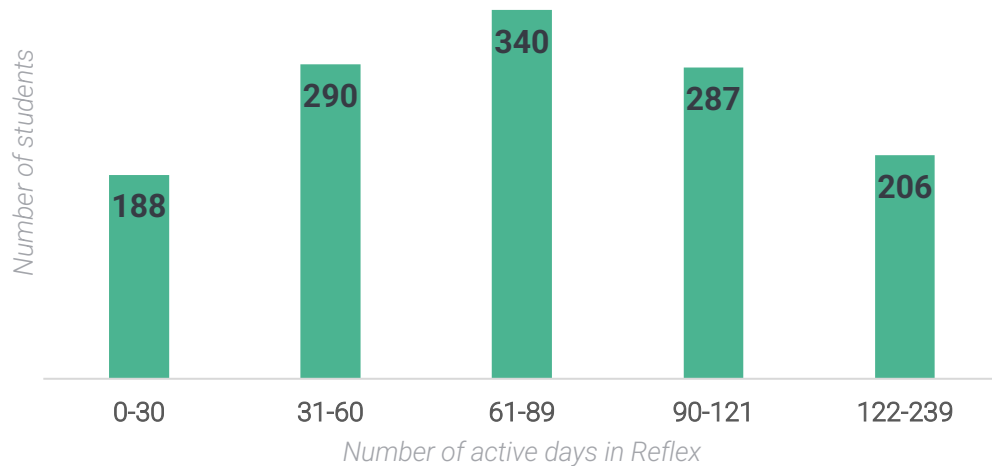


38% of Grade 4 students completed 14 or more Frax missions and 24% completed the recommended dosage of 22-27 Frax missions.

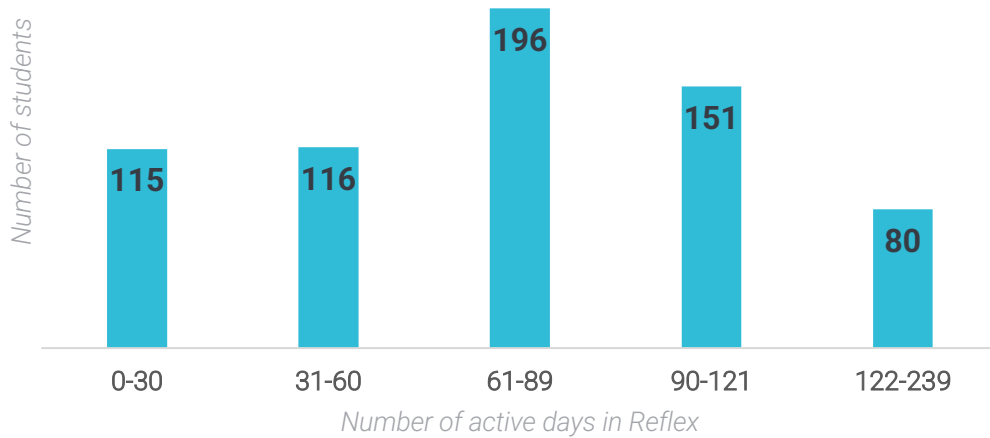


Similarly, researchers conducted a *k*-means cluster analysis to group students by similar levels of usage based on their total number of active days on Reflex in the 2021-22 school year. Overall, students fell into five usage categories ranging from very low usage (0-30 active days), low usage (31-60 active days), medium usage (61-89 active days), high usage (90-121 active days), and very high usage (122-239 active days). The graphs that follow depict Reflex usage groups overall and by grade level.

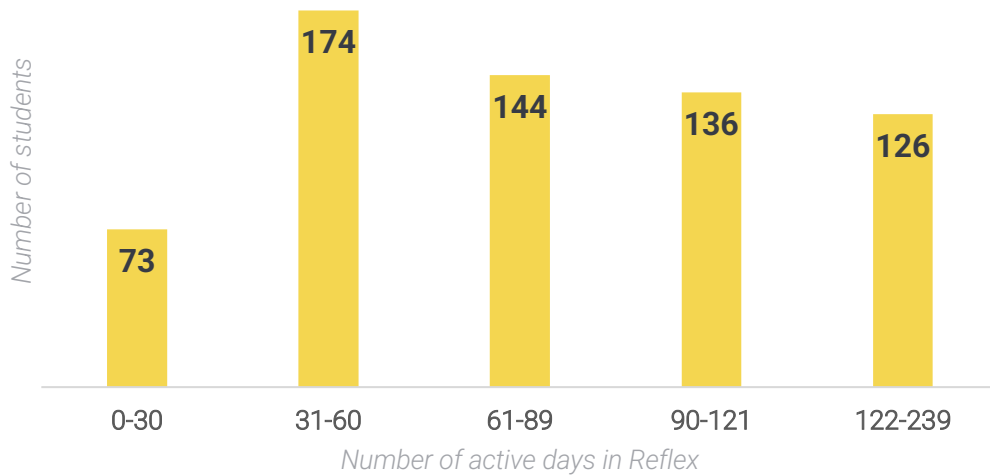
70% of students had between 31 and 121 active days in Reflex.



70% of Grade 3 students had between 31 and 121 active days in Reflex.



70% of Grade 4 students had between 31 and 121 active days in Reflex.

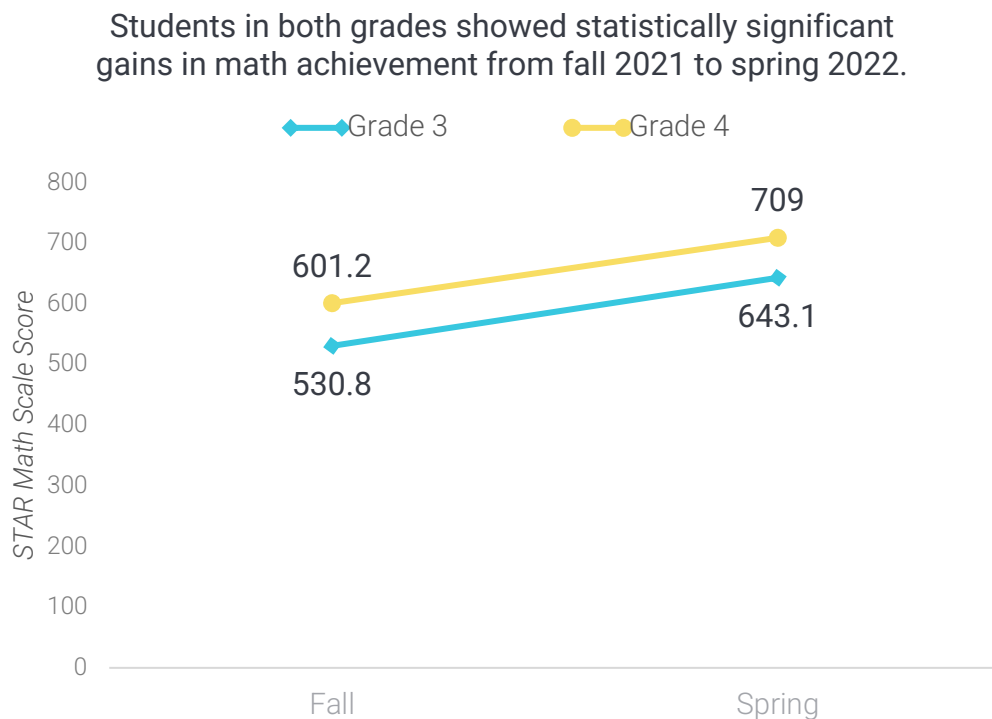


Findings

To answer the study research questions, conducted paired t-tests and partial correlations. The following sections detail the findings for the treatment-only, correlative design.

Outcomes for Frax students

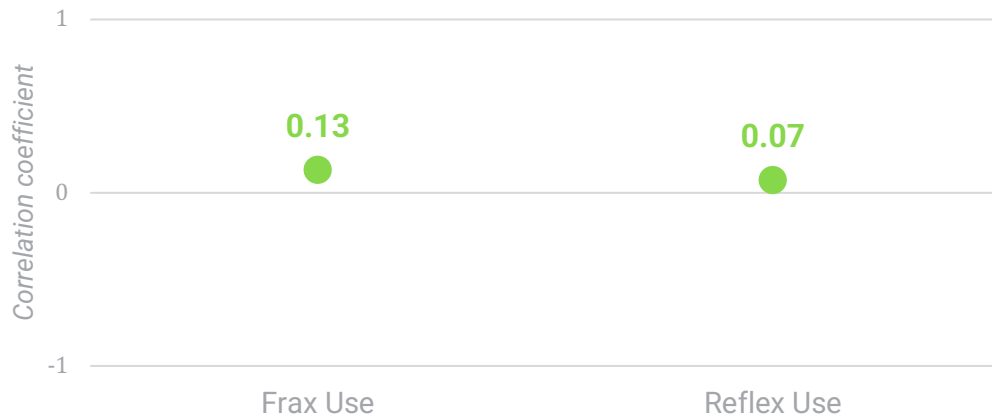
Math Achievement Gains. Researchers examined average math achievement scores before and after Frax students used the program in the 2021-22 school year. Based on visual examination of the data, students had higher math achievement over the course of the study, and both grade level gains were statistically significant ($p < .05$; [Appendix C](#)).



Overall Math Achievement. Researchers first examined whether greater usage of Frax was related to higher spring STAR Math achievement using partial correlations that included fall STAR Math achievement, Reflex usage, and grade level as covariates. Researchers report statistically significant findings at the $p = .05$ level. Statistically significant findings are marked green (positive correlation) or red (negative correlation) in correlation coefficient graphs. Findings that are not statistically significant are marked yellow.

There was a positive, statistically significant relationship ($p < .001$), such that students who completed more Frax missions had higher spring STAR Math achievement. Additionally, students who spent more days in Reflex had statistically significantly higher spring STAR Math achievement ($p < .01$).

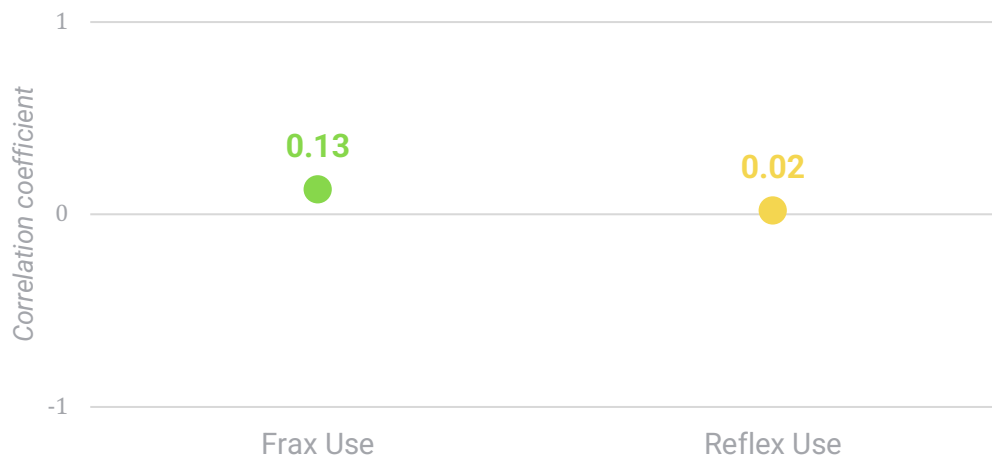
Students who completed more Frax missions had higher spring math achievement. Similarly, students who had spent more days in Reflex had higher spring math achievement. These findings were statistically significant.



[Math Achievement by Grade](#). Researchers also examined whether greater usage of Frax was related to higher spring STAR Math achievement for each grade separately. They used partial correlations that included fall STAR Math achievement and Reflex usage as covariates.

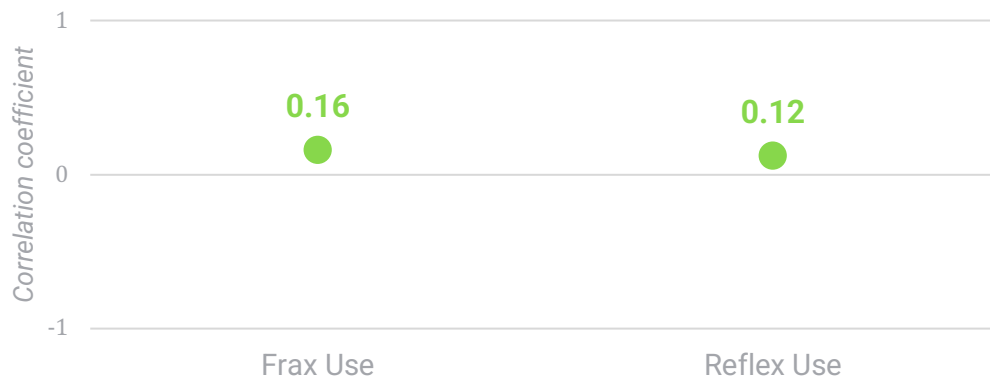
Among Grade 3 students, there was a positive, statistically significant relationship ($p < .01$), such that students who completed more Frax missions had higher spring STAR Math achievement. The relationship between Reflex use and spring STAR Math achievement was positive but not statistically significant.

Grade 3 students who completed more Frax missions had higher spring math achievement. This finding was statistically significant.



Among Grade 4 students, there was a positive, statistically significant relationship ($p < .001$), such that students who completed more Frax missions had higher spring STAR Math achievement. Additionally, Grade 4 students who spent more days in Reflex had statistically significantly higher STAR Math achievement ($p < .01$).

Grade 4 students who completed more Frax missions had higher spring math achievement. Similarly, Grade 4 students who had spent more days in Reflex had higher spring math achievement. These findings were statistically significant.



Exploratory subgroup analyses

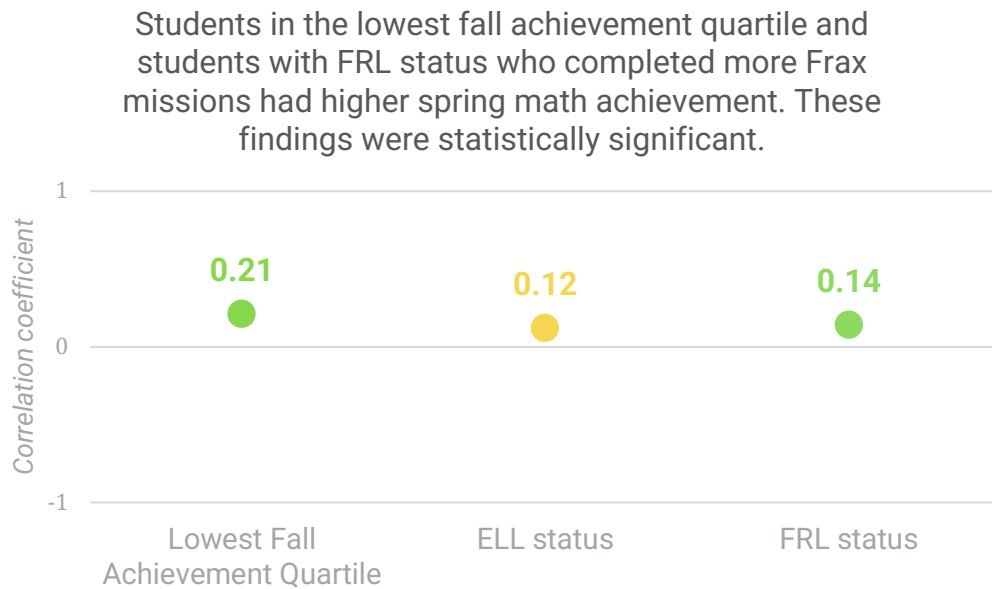
Researchers then conducted several analyses for different student subgroups, examining the relationship between student usage of Frax and spring STAR Math achievement, while controlling for grade level and fall STAR Math achievement. Researchers did not include Reflex usage as a covariate, as it was not statistically significant in any subgroup analysis.

Students in the Lowest Fall Achievement Quartile. Researchers stratified the sample by grades and then categorized students into four quartiles based on the distribution of fall STAR Math scores. Grade 3 students in the lowest quartile (i.e., low achieving students) had fall STAR Math scores below 473.5 ($n = 160$) and Grade 4 students in the lowest quartile had fall STAR Math scores below 553 ($n = 159$). Students in the lowest quartile completed 6.3 Frax missions (SD = 8.0), on average. Researchers conducted a similar partial correlation analysis as above for the low achieving student group and found a positive, statistically significant relationship for Frax usage ($p < .001$), such that low achieving students who completed more Frax missions had higher spring STAR Math achievement.

English Language Learner (ELL) Status. Researchers conducted a partial correlation for students who had ELL status ($n = 214$) while controlling for grade level and fall STAR Math achievement.

Frax usage trended toward significance in the analysis for ELL students ($p = .09$), such that students who completed more Frax missions had higher spring STAR Math achievement.

Socioeconomic (FRL) Status. Researchers conducted a partial correlation analysis for students who has FRL status ($n = 464$) while controlling for grade level and fall STAR Math achievement. Frax usage was statistically significant in analyses for FRL students ($p < .01$), such that students who completed more Frax missions had higher spring STAR Math achievement.



Conclusions

Given positive outcome findings, this study provides results to satisfy ESSA evidence requirements for Level III (Promising Evidence). Specifically, this study met the following criteria for Level III:

- ✓ Correlational study
- ✓ Proper design and implementation
- ✓ Statistical controls through covariates
- ✓ At least one statistically significant, positive correlation with statistical controls for selection bias

In future studies, Explore Learning could consider recruiting schools that have more students meeting the recommended dosage (22-27 missions completed) for Frax at Grade 3 and compare these results to third grade students who have not used Frax.

Recommended Next Steps

For next steps, we recommend that Explore Learning select and recruit a district with:

- more students meeting the recommended dosage for Frax at Grade 3,
- a comparison group of students that uses neither Frax nor Reflex, and
- different student demographics to examine how the program works in different contexts.

References

Shah, M. & Styers, M. 2022. *Frax Logic Model*. Study Type: ESSA Evidence Level IV. LearnPlatform.

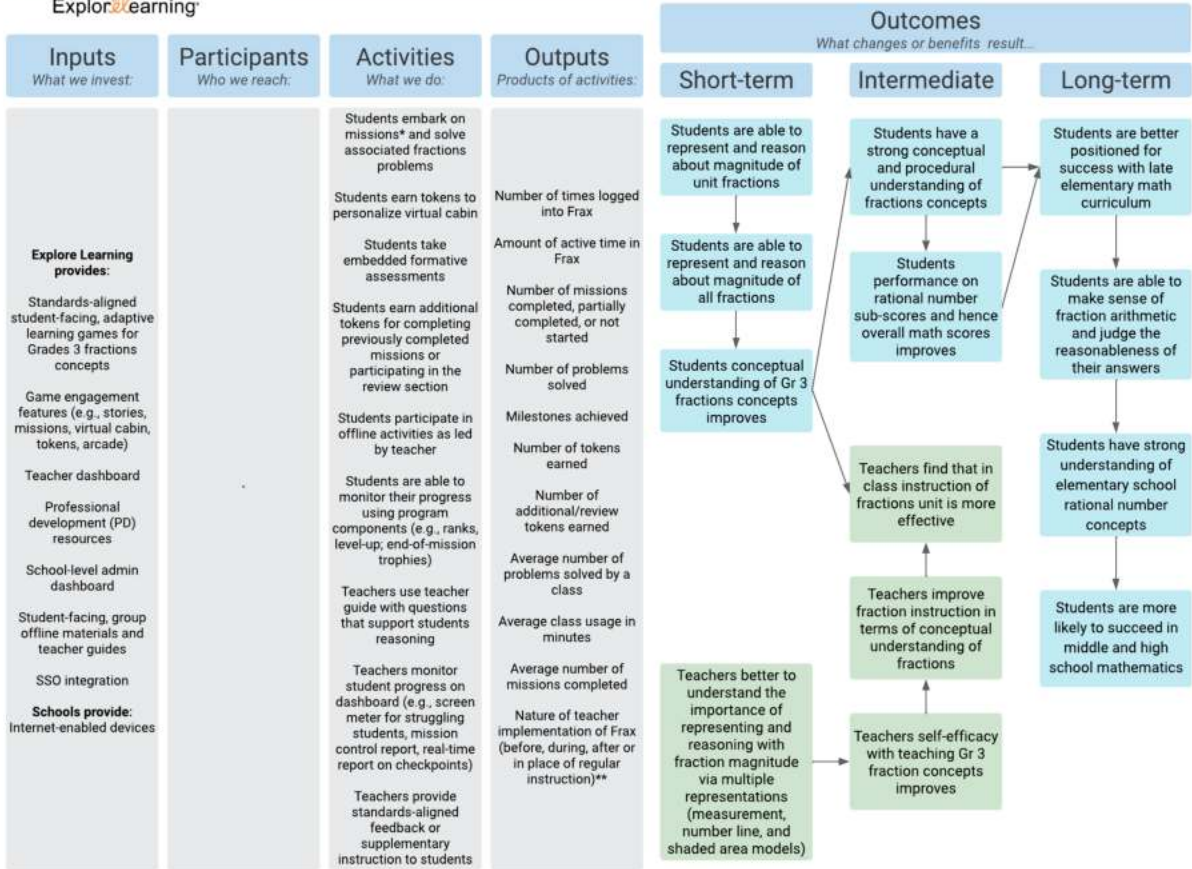
What Works Clearinghouse. (2022). What Works Clearinghouse procedures and standards handbook, version 5.0. U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance (NCEE). This report is available on the What Works Clearinghouse website at <https://ies.ed.gov/ncee/wwc/Handbooks>. [See Appendix E in the standards for further reading about the WWC Improvement Index]

Appendix A. Frax Logic Model



Explore Learning

Problem Statement: Students in the US tend to perform poorly on fractions. Unfortunately, knowledge of fractions at the end of elementary school predicts students' mathematics achievement in high school. Therefore, students who struggle with fractions tend to have difficulties understanding Algebra and are thus less likely to progress to more advanced mathematics coursework, which in turn closes the door to many highly sought after STEM careers.



*Mission - lessons that draw on one or more of the Grade 3 fractions standards
 ** Teachers use Frax to: 1) let students independently prepare for an upcoming fractions unit; 2) replace existing curricular unit on fractions, including group offline lessons; 3) supplement regular instruction; and 4) after curricular unit on fractions.

Figure 1. Frax logic model

LearnPlatform © 2022

Prepared for Explore Learning, April 2022



Appendix B. Additional Information on Study Design and Methods

Additional Information on Participating Schools

The present study included eight elementary schools in one public school district in California. None of the schools in the district qualified for Title I status. Table B1 documents NCES school-level demographic data for the participating elementary schools.

Table B1. Description of participating schools

	School A	School B	School C	School D	School E	School F	School G	School H
Number of participating students	71	215	125	160	163	202	168	176
Locale	Suburb: Large	Suburb: Large	Suburb: Large	Suburb: Large	Suburb: Large	Suburb: Large	Suburb: Large	Suburb: Large
Total grades 3 & 4 students	150	245	141	186	139	220	183	186
Total students at the school	445	643	434	505	427	671	459	548
% Students on Free & Reduced Lunch	35	30	57	35	43	49	29	16
% American Indian/Alaskan Native	0	0	0	0	0	0	0	0
% Asian	8	14	6	12	6	7	3	16
% Black	1	2	5	1	3	3	3	1
% Hispanic or Latino	56	49	62	54	63	64	52	33
% Native Hawaiian/Pacific Islander	0	0	0	0	0	0	0	0
% White	27	22	18	23	21	20	31	37
% Two or more races	7	12	9	11	6	7	11	13

Source: 2020-2021 data retrieved from IES, NCES Common Core of Data <https://nces.ed.gov/ccd/>

Participant Demographics

The sample consisted of 1,311 students in Grades 3 and 4 across eight elementary schools in one public school district in California. The analytic sample included students who had fall and spring STAR Math achievement data ($n = 1243$).

Table B2. Description of participating students

	Grade 3		Grade 4	
Total students	658		653	
	n	%	n	%
American Indian/Alaskan Native	12	2	9	1
Asian	116	18	89	14
Black	29	4	33	5
Native Hawaiian/Pacific Islander	9	1	5	1
White	378	57	387	59
Declined to state	114	17	130	20
Hispanic or Latino	360	55	338	52
English language learners (ELL)	111	17	121	19
Free and reduced-price lunch (FRL) status	253	38	252	39

Measures

Frax usage data. Researchers accessed classroom-level usage data for 3rd and 4th grade students in the 2021-22 school year. Specifically, researchers collected the following classroom-level usage data:

- number of Frax missions completed, and
- number of active days in Frax's companion learning solution, Reflex.

While Explore Learning recommends that Grade 3 students complete all 27 Frax missions to gain a full understanding of the Grade 3 fractions content standards, they consider strong implementation of their product to be between 22-27 Frax missions completed.

Renaissance STAR Math® scaled scores. STAR Math scaled scores range from 0-1400. A scaled score is calculated based on the difficulty of questions and the number of correct responses.

Because the assessment is vertically scaled, scaled scores can be used to compare student performance across grade levels.

Appendix C. Additional information on outcome findings

Math Achievement Gains. Researchers conducted paired t-tests to examine differences in math achievement scores from fall 2021 (pretest) and spring 2022 (posttest) for students who used Frax over the school year. There were statistically significant gains in math achievement. Results of the paired t-tests by grade are presented in Table C1.

Table C1. Means and standard deviations for STAR Math scale scores

	Pretest Mean (SD)	Posttest (SD)
Grade 3 students*** ($n = 629$)	530.8 (88.7)	643.1 (81.7)
Grade 4 students*** ($n = 613$)	601.2 (82.0)	709.0 (91.1)
Overall*** ($n = 1243$)	565.6 (92.4)	675.6(92.5)

Gains between pretest and posttest results for Grade 3 students were statistically significant $t(628) = -50.6, p = 0.000$. Gains between pretest and posttest results for Grade 4 students were statistically significant $t(613) = -49.0, p = 0.000$. Finally, overall gains between pretest and posttest results were statistically significant $t(1242) = -70.4, p = 0.000$.