RESEARCH BRIEF

Qualitative Year-Long Frax Study Reveals Increased Fractions Knowledge and Confidence

Frax Foundations I was released in early Spring 2021. In Fall 2022, a cohort of teachers representing a diverse group of students were invited to participate in a year-long user testing program. They used Frax I with their students and provided product feedback via surveys (October, March) and interviews (January, May). This research report provides a summary of the analyses of the responses across all four timepoints.

PARTICIPANTS

Eight teachers and 215 3rd-5th grade students were given access to the Frax program for the 2022-2023 school year. The teachers who participated in the program taught at schools across eight different states in the US, with varying demographics and school sizes. Table 1 contains more information about each school.

Table 1: School populations and student demographics for all participating teachers

	US Region	School Size and Grades	Locale	Title 1	Percentage of students qualifying for FRPL	Student Demographics
1	Midwest	200 4-5	Rural - Fringe	No	30%	80% White
2	West (Pacific)	750 K-5	Town - Remote	Yes	50%	26% Asian, 20% Hispanic, 17% Pacific Islander, 33% multiracial
3	West (Mountain)	450 K-6	Suburb - Large	No	15%	70% White, 14% Hispanic
4	South (Central)	720 K-5	City - Small	Yes	60%	60% Hispanic
5	South (Atlantic)	550 K-5	Town - Distant	Yes	60%	90% White
6	Midwest	500 5-7	Town - Distant	Yes	45%	95% White
7	South (Atlantic)	975 K-5 (Magnet School)	Suburb - Large	No	10%	80% White, 12% Black
8	South (Central)	350 K-4	Suburb - Small	Yes	100%	50% Black, 30% White, 14% Hispanic

Most teachers were veteran teachers, with a range of 10-33 years of classroom teaching experience (average=19 years). The teachers also represent a large variation in training (i.e., recreational therapy, resource and language intervention, SPED certification, ESL certification) and teaching experience (i.e., all grades from kindergarten through 7th grade). All current students ranged from 3rd–5th grade, and achievement levels ranged from accelerated to intervention classrooms.

METHODOLOGY

The teachers participating in the study provided feedback at four points throughout the school year. Online surveys were administered in the fall and in the spring, and 1:1 semi-structured interviews were conducted in the winter and at the end of the school year. Appendix A provides survey and interview questions. Participation rates were high, with all teachers completing both interviews and 75% of teachers completing both surveys.

PRE-IMPLEMENTATION INSIGHTS

HIGH LEVELS OF STUDENT CHALLENGES. The students in this study come from varied social, economic, cultural, and regional groups. There were some specific challenges noted by teachers related to those differences, such as language backgrounds, levels of parental involvement, and home stability. In addition, many teachers mentioned navigating teaching challenges such as mixed-level classes, an increase in students with IEPs/RTI, and large differences in student motivation levels.

However, most of the student challenges mentioned were shared experiences attributed by teachers to COVID-related learning disruptions. The 3rd-grade cohort was seen by teachers as coming into class lacking the necessary skills for classroom success, including basic math knowledge, on-grade reading levels, appropriate social behavior, attention spans, and engagement. They perceived these students as less "intellectually curious" and more afraid to fail than previous cohorts. The table below highlights some of the most common COVID-related concerns mentioned in these interviews and some representative teacher quotes.

Table 2: A selection of teacher quotes about common student challenges to classroom math success.

Not prepared to be independent learners	*At home, they either were not attentive in school if we were Zooming …or they had their parent right there to kind of spoon-feed information to them. **They've never had to be independent learners**. So now they're nine and ten years old, and we're telling them they have to be an independent learner…It's a hard transition for them to make.*	
Lack of self-confidence as learners; afraid to fail (fixed mindset)	*They're not seekers of knowledge …they're socially afraid to speak up. They kind of live within their own bubble… **they don't have the confidence to admit that they don't know something, and they will not ask questions**.*	***They're learning very quickly how to manipulate the system** so that people don't recognize that [they do not know something]. So they pretend like they're taking notes, or they pretend like they're working, but they're not really writing anything that has to do with the problem. They're just writing numbers. They don't know what to do with them.*
Lack of foundational math skills	*They were so low in their multiplication fluency…they came to me at the beginning of the year at 19% fluent. So it was a struggle to get through a multiplication unit because we don't know our multiplication facts…**fractions require a lot of multiplication knowledge. And when we don't have that knowledge… fractions seem untouchable**. It's like a foreign language.*	*We have a hard time with kids still coming into third grade having to count on their fingers. Like, they don't understand that they have ten fingers. They will literally count 1, 2, 3, 4, 5. So just trying to get them to recognize that. I'm really big into trying to get them concepts of ten, which is really hard for students.*

LOW BASELINE KNOWLEDGE OF FRACTIONS. Most of the 3rd-grade teachers said that their students came into the classroom with almost no fractions knowledge (Table 3). One teacher said:

> *"I always start the year [by] asking the kids to write down everything they know about fractions. And this group sat there and said, what if I don't know anything about fractions?"*

The 4th-grade teachers noted their students had familiarity with fractions vocabulary, but a lack of understanding of the concept that was related to those terms. For example:

> *"They knew what the word equivalent meant. They knew that it meant the same, but they really struggled to see how two fractions could occupy the same space."*

Table 3: Percent of teachers reporting their students' average baseline knowledge of fractions as none, some, moderate, or considerable knowledge.

	No Knowledge	Some Knowledge	Moderate Knowledge	Considerable Knowledge
Understanding number lines	25%	50%	25%	0
Understanding area models	25%	75%	0	0
Understanding length models	50%	37.5%	12.5%	0
Number line estimation	50%	37.5%	12.5%	0
Comparing and ordering fractions	87.5%	0	12.5%	0
Equivalent fractions	87.5%	12.5%	0	0

PLANS FOR IMPLEMENTATION. Most teachers (62.5%) said they were starting Frax before their in-class fractions unit to increase student readiness for instruction. The remaining teachers (37.5%) said they were planning to start Frax at the same time as in-class fractions instruction. Every teacher reported using Frax in independent 1:1 computer time, like morning warm-up, math instruction block, or independent work time. Home-based usage was lower (25%) with teachers noting that technological barriers (e.g., no computer access at home, unreliable internet) made this method of use inequitable.

GOALS FOR FRAX USAGE. Nearly all the teachers said that their goals for using Frax in the classroom were to prepare their students to learn grade-level content by filling in knowledge gaps, such as basic fractions vocabulary (numerator, denominator, etc.), fractions on a number lines, and fractions equivalence. Many teachers mentioned a "strong foundation" in fractions knowledge as the goal for preparing students both for in-class instruction and state testing. For example:

"Fractions is a huge part of our state test, so I hope they will be successful with those questions by May."

Teachers were asked to rank the level of importance of a variety of outcomes in their students as a result of using Frax (Table 4).

Table 4: Percent of teachers rating specific student outcomes related to Frax usage from low to high importance.

	Low Importance	Somewhat Important	Important	Very Important
Increased confidence in math abilities	0	0	12.5%	87.5%
Better memory for what they have learned	0	12.5%	12.5%	75%
Increased critical thinking	0	12.5%	12.5%	75%
Increased enjoyment in math	0	0	37.5%	62.5%
Increased autonomy in their own learning	0	12.5%	25%	62.5%
Applying knowledge to solve real-world problems	0	25%	12.5%	62.5%
Improved math discourse	12.5%	12.5%	12.5%	62.5%
Decreased math or testing anxiety	0	12.5%	37.5%	50%
Deepening math interest	0	25%	25%	50%
Increased self-efficacy in math learning	12.5%	12.5%	25%	50%
Increased class climate (more engagement, less student disturbance)	0	12.5%	50%	37.5%
Increased math test scores	12.5%	0	50%	37.5%

POST-IMPLEMENTATION INSIGHTS

In the spring, teachers were asked to rate the degree of change observed in their students in a variety of areas (scale of 1-5) as a result of using Frax in the classroom. The top 5 largest changes observed included increased enjoyment in math (n=3.8), deepening math interest (n=3.67), increased class climate (e.g., more engagement, less student disturbance) (n=3.67), improved math discourse (n=3.67), and increased confidence in math abilities (n=3.5).

INCREASED STUDENT ENJOYMENT AND ENGAGEMENT

Increased enjoyment in math was the largest area of change observed by teachers in the study. Teachers largely felt that their students, who they frequently mentioned are "digital natives," are succeeding with Frax because they are enjoying it. They cited the gamification, rewards, room personalization, and visuals as particularly engaging aspects of the system. Multiple teachers noted that their kids expressed a preference for Frax over other technology products (e.g., Ready Math, Khan Academy), asking to use it even more than currently assigned.

> *"All the kids love Frax. They really do. It's engaging."*

> *"The students enjoy fractions and beg me to open new [Frax] missions."*

> *"My students who have completed more missions are loving fractions...and they are proud of their high scores."*

> *"My students are loving fractions! They tell me how much they enjoy learning about fractions every time we are able to complete Frax."*

Teachers also mentioned benefits specifically for more at-risk students, like students with IEPs, ADHD, and students in intervention. One teacher described how her 5th grade improvement students are currently at a 3rd grade level for fractions. Most computer-based programs she tried previously for 3rd grade math were perceived by these older students as "baby-ish". With Frax, her students found it fun and engaging, and they didn't feel like it was too young for them. Another teacher noted that her students with ADHD seemed to stay engaged and attentive to Frax longer than other classroom fractions activities, helping them to learn better. Another teacher noted that her students with IEPs who typically need additional help to complete independent work on other online programs were able to use Frax independently, which benefits all students.

> *"They have success with it independently and they're kind of increasing their ability just to persevere and do something on their own and not need someone there with them. But also, then I can be available to do my one-to-one teaching with someone else because I know what they're doing is something that they're actually getting something from."*

INCREASED STUDENT KNOWLEDGE AND TEST SCORES

All teachers noted large increases in specific areas of fractions knowledge:

> *"[Frax] increased their ability to recognize when a fraction represents a value greater or less than one."*

> *"Students moved easier than other years into decimal fractions."*

> *"Students are understanding the differences between the numerator and denominator, unit fractions, and fractions on a number line."*

"The ability to understand … benchmark fractions was huge. That I could say, 'Where is one half? Is it bigger than one half or smaller than one half?' And they knew what one half was, where it would fall in the number line, and could tell me based on the denominator, if it was in more pieces or less pieces, and if that number was equivalent to one half or not…It did not take me nearly as long for them to grasp the concept of relational fractions."

"It was nice because they had all had some kind of foundation and exposure to fractions because of Frax before we even started it."

After just a few months of usage, this translated into observed increases in their students' performance on mathematics assessments. One teacher noted that her students using Frax this year were passing fractions questions on informal assessments (spiral review) before she even covered them in class.

"I had 50% without teaching the fractions unit pass their quarterly benchmark on fractions."

"Their fractions grades are better than they've been the last, like, two years. I could see, like, a shift in perception from everybody."

"We took our mid-unit test today. Only two students scored below 70%. Most of my students scored above 80%."

By the end of the school year, teachers were reporting large, measurable gains on standardized assessments compared to previous years and their peers, which they attributed to Frax.

"My students' fraction ability increased from an average of 58% to 89%."

"Everybody [who used Frax] scored grade level or above [on the end of year test in the fractions area]."

"For our state testing…I had more level fours [above grade level] than I have ever seen in a grade level class before…58% of my class scored on or above grade level, which is 10% better than our state average."

"I'm working on their final grades right now for the year-end grades. And I have way less people that got 'well below' in fractions. I have a majority 'developing,' 'meets,' and 'meets with excellence.' I don't even think I had 'meets with excellence' in the past…. the only thing I did differently was Frax."

"The ones who are further along [in Frax] had the most [i-Ready math score] growth from the beginning of the year to the end of the year."

"On the fractions area of the state testing…compared to the other grade level class, my class did a lot better."

IMPROVED CLASSROOM CLIMATE

All teachers noted that classroom conversations were more productive, teaching was more efficient, and student participation was higher due to Frax.

"[Frax] improved students' abilities to understand the concept of fractions making our curriculum lessons and discussions more effective."

"When I taught them the relationship between fractions/decimals/percents they got it quicker."

"I have shortened the number of overall days of having to teach the fraction unit."

"I teach grade level, and I was able to get through fractions faster than the other grade level group just about as fast as the advanced class."

Teachers consistently noted that students were mastering a basic understanding of fundamental fractions concepts and vocabulary earlier than before, leading to increased student participation in class discussions. This was also observed in the way that students could explain those concepts to other students.

"Sometimes the vocabulary of it has been a hindrance ...I can at least have conversations with them [about fractions] when I'm teaching that they're able to understand what I'm trying to explain."

Many teachers saw their students making direct connections between material in Frax and classroom content:
"A lot of times when we're doing our regular math, they'll go, 'Oh, I learned this in Frax.'"

"They can relate what they learn on Frax to what we are discussing in the classroom."

INCREASED STUDENT CONFIDENCE

Even at the first interview timepoint, just a short time into using the program, several teachers noted an increase in confidence and pride in their students as a result of the knowledge increases gained from Frax, especially amongst their lower achieving or math hesitant students.

"Students seem less reluctant to complete problems involving fractions."

"Students are more comfortable discussing and working with fractions."

"They look at fractions in a much less threatening way."

Other teachers noted that their hesitant students prefer digital learning approaches like Frax compared to classroom learning because the privacy aspect of digital learning makes them feel more confident and comfortable with potential failure. One teacher said:

"I think it's also kind of blind to everybody else. So when I put fraction models in front of them and they have to model them on the desk kind of everybody can see what they're doing and see that they don't understand.

Where a digital component like this my kids can go anywhere in the class where they want to sit with their headphones and nobody has to see what they're doing."

Another program feature, the gamification aspect, also decreased children's apprehension around engaging in a math exercise:

"For those kids that are afraid, I think the format…is excellent, that it does feel like a story or a game, and it's not intimidating in any way…I have some kids that are very reluctant to do math but will hop on Frax."

CONCLUSION

The current summary of the survey and interview feedback collected from this small group of teachers over the 22-23 school year provides important insight into the benefits of Frax for a diverse group of students. Despite their students starting out with very low baseline fractions knowledge, these teachers all observed large increases in students' math confidence, enjoyment in math, improved math discourse, and increased class climate. Even though teachers ranked improved test scores as the least important goal of using Frax, it was the most widely noted change in interviews at the end of the school year. All of the teachers noted measurable increases in skills compared to previous years and compared to their peer classes. This qualitative study provides detailed information to support other quantitative analyses recently conducted by ExploreLearning that show significant increases in students' math knowledge after using Frax.

Appendix A: Surveys and Interviews

In October 2022, online surveys were sent to all participating teachers and asked a number of questions about their previous teaching experience, students' fractions knowledge, and plans for Frax usage including:

- As a group, how much foundational fractions knowledge do your students have?
- What do you hope your students will learn by using Frax?
- When/where/ how do you plan to use Frax?
- What are the most important outcomes that you want Frax to product in your students?

In January 2023, the ExploreLearning Senior Researcher conducted semi-structured, individual interviews with each teacher. The questions asked to each teacher include:

- What are some of your students unique personal or academic challenges?
- What are your students' previous experiences with fractions/baseline fractions knowledge?
- What are your goals for using Frax in your classroom?

In March 2023, online surveys were sent to all participating teachers and asked a number of questions about observed outcomes from using Frax, including:

- What changes in attitudes towards fractions learning/knowledge of fractions have you observed in your students?
- How did Frax impact in-class fractions instruction?

In May 2023, the ExploreLearning Senior Researcher conducted semi-structured, individual interviews with each teacher. The questions asked to each teacher included:

- What were students' experiences using the Frax program?
- How did Frax impact in-class fractions instruction?
- What impact did you observe on grades/standardized tests/benchmark assessments?
- Why is Frax working for your students?