LXD RESEARCH
ESSA
Level 3
Evidence

First In Math
ESSA Packet

RESEARCH-BASED DESIGN, LOGIC MODEL, EFFICACY CASE STUDY SUMMARY




First in Math is a math practice tool that leverages students' love of online gaming to build math skills and create high levels of engagement. Using innovative game-based learning technologies, students are provided with instant feedback, direct instruction, and the freedom to make mistakes without penalty.

First in math®

Learning Experience Design (LXD) Research & Consulting
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UNDERSTANDING
ESSA Evidence

OVERVIEW

Evidence guidance under the Every Student Succeeds Act (ESSA) are designed to ensure that states, districts, and schools can identify programs, practices, products, and policies that work across various populations.

The Every Student Succeed Act (ESSA) requires education programs to provide evidence of effectiveness and impact in order to be federally supported. The Department of Education's Office of Educational Technology provides standards to assess the varying levels of strength of research for education products. The categories for ESSA Evidence are: strong, moderate, and promising evidence of effectiveness, or demonstrates a rationale to be effective. Once your company demonstrates a rationale, education leaders typically are more receptive, viewing your products as credible for enhancing student performance.

Four indicators to show your product meets Level 3: Promising Evidence Requirements

- In correlational design, students who used the program are compared to normed referenced samples or other group averages for comparison.
- Multiple studies with the proper design and implementation with at least two teachers and 30 students show statistically significant, positive findings.
- The study uses a form of a program that could be replicated.
- A third-party research organization has reviewed the documentation for ESSA validation

"When product designers leverage learning sciences to design their products, educators can better target instruction, and students' skills soar. Through interviews with the product designers and an evaluation of their research-informed activities, First in Math has earned the Digital Promise Evidence-Based Edtech: ESSA Tier 3 Product Certification, communicating to district leaders this product is indeed built on research. With additional examples correlational studies, the product meets the criteria for LXD Research's ESSA Level 3 Evidence."

– Rachel Schechter, Ph.D., Founder of LXD Research

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First In Math Online is a proven math-practice tool that leverages students' love of online gaming to build math skills and create high levels of engagement.

Students play more than 200 meaningful K-8 math games they can relate to—games that are difficult enough to hold their interest but not so difficult that they give up in frustration. In this environment, students practice willingly, the way they do for sports!

LEVERAGES THE LOVE OF GAMING

First In Math recognizes that games reduce overall anxiety levels in students, leading to heightened student engagement and increased time dedicated to math practice.

INSTANT FEEDBACK

First In Math's game-style activities provide immediate feedback, to ensure that students engage in the amount of Deep Practice necessary for skill retention.

QUICK & EASY

Use just fifteen minutes a day to produce results. Students enjoy First In Math so much that nearly 50% use it in their free time.

ALL SKILL LEVELS WELCOME

Serves a range of skill levels - student GOALS tool is personalized. Meets the diverse and unique needs of all learners, creating growth opportunity for all.

FRIENDLY & MOTIVATING

Friendly "Team" approach adds enthusiasm and provides motivation. Teachers also overwhelmingly agree that students enjoy the program and seek out time to use the First In Math online math program.

RESEARCH-BASED

FIM utilizes an engaging digital learning format with more than 20 years of proven results. Studies done by WestEd, Stanford Research Institute, and Lehigh University document that First In Math significantly improves attitudes and math proficiencies for elementary students.

Math Mavericks: Unveiling the Power of Evidence-Based Strategies

In 1988, Robert Sun developed the 24® Game, which aims to teach number relationships through play, engaging students from diverse economic and social backgrounds. With the advent of widespread internet access in 2002, Sun launched First In Math, an online program that prides itself on effective and engaging math practice, applying evidence-based strategies for math fluency and skill development.

First in Math now boasts over 200 games spread across a number of math skills and concepts, increasing in complexity as **learners gain competence and confidence in math**. First in Math's approach to increasing math proficiency, a fundamental requirement for many STEM and 21st Century careers, is focused on addressing two potential blockers: (a) Students feel anxious about math and hence do not engage, and (b) Students often lack mathematical factual and procedural fluency and automaticity that can support advanced problem solving and computational thinking.

The 24 Game was successful at leveraging games as a tool for learning math. With widespread access to personal computers and the internet, First In Math was developed to engage learners to practice math through games aligned to math standards. Prior research suggests including learning supports such as accuracy feedback, unlimited attempts, information tutorials and hints, focused constraints, progressive levels, and features that support game efficiency (e.g. click into place) when the focus is on math fluency (Moyer-Packenham et al., 2019). First In Math employs these supports in most games, providing students with immediate feedback on accuracy, unlimited attempts, timed games, and other focused constraints, and information tutorials and hints to complete games that increase in complexity as the student gains proficiency. Additionally, games are designed to be visually and mechanically simple to increase game efficiency, reduce extrinsic load, and optimize students' attention to math learning. In this post, we highlight a few ways First in Math applied **evidence-based strategies** in its design to bolster effective and engaging learning (de Mooij et al., 2020)

Strategy 1: Gamification of Math Practice

While gamification of learning has picked up mainstream hype in the past decade, Robert Sun embodied the idea of developing the 24 Game and 200+ digital games over two decades ago. A review of 15 studies conducted with a total of 1300+ students found that students who learned math using games felt a lower level of math anxiety than those who didn't (Dondio et al., 2023). This effect was especially pronounced when students engaged in collaborative non-digital gameplay and spent more time playing the math game. Recognizing that games overall reduced anxiety levels, First in Math optimized for both collaborative non-digital gameplay and independent digital games with unlimited duration offering our customers choice while aligning with existent evidence.

Strategy 2: Building automaticity for efficient computation

Learning mathematics has a compounding element in which a student must master a core set of facts and concepts before being able to execute more advanced problems. For instance, a learner with strong fact and procedural fluency leading to automaticity (i.e. being able to "know" the answer without conscious thought) will likely find it **easier and more efficient to engage in more advanced problem-solving and computational thinking problems.** Given this critical role of fact fluency and the fact that many students struggle at this fundamental level, partly due to the need for rote memorization, First in Math developed a patented strategy, VIF (Very Important Facts), that **reduced the number of facts that students needed to learn by nearly 60%.** This strategy is taught explicitly in mini-lessons and video tutorials, providing both the facts and the problem-solving strategy to quickly compute the other facts as needed. Such videos are followed by practice of the strategy. This integrated approach (i.e., strategies and timed practice drills) mirrors previous research that found students who adopted an integrated approach for 25 minutes a day, five days a week, for four consecutive weeks scored better in both immediate tests and long–term tests that asked additional facts and tasks not explicitly practiced as compared to students who trained with only timed math practice drills (Woodward, 2006).

Strategy 3: Offering modes of independent, collaborative, and competitive practice

Learning is essentially a change in an individual's mind, but it can be so much more engaging when done collaboratively or using games - or both! In a between-group study in which students were randomly assigned to either individual, competitive, or collaborative gameplay for math practice, researchers found that the mode of gameplay did not significantly vary math fluency outside of the game (Plass, 2013). However, when looking at in-game math performance, they found that competition **increased performance** while collaboration decreased performance. Additionally, students in the competition and collaboration conditions demonstrated greater interest, **increased enjoyment**, and a **stronger sense of mastery-goal orientation** than in individual play. In other words, collaboration and competition may enrich the learning experience, even if not the learning outcome. Given First in Math's dual focus on learning experience and outcomes, the core set of individual games remains with expanded and additional options for competition, such as the Rankings Feature and Goals Index (as a class against a district leaderboard) and collaboration (an online version of the original 24 game) are offered to avail the affective benefits.

The Goals Index, an intentional goal-setting feature on the FIM online program, supports mastery orientation by measuring students' persistence in mathematics thinking, fluency in all four operations (addition, subtraction, multiplication, and division), procedural fluency, and word-problem-solving skills.

Strategy 4: Interleaving direct instruction and practice

Using direct instruction in mathematics was the most common pedagogical approach in a review of 26 studies on math instruction (Kacmaz & Dubé, 2022). Particularly, the researchers found that direct instruction, delivered through drill-and-practice games that built factual, procedural, or conceptual fluency, **significantly improved math scores - particularly as it relates to fact fluency**. First In Math applies direct instruction in two ways: (a) mini-lessons that provide explicit and direct instruction of math facts, procedures, and strategies and (b) games in varied formats that engage learners to apply and practice their factual, procedural, and conceptual fluency. Students can monitor their progress on the Goals Index.

Efficacy of First in Math

In addition to numerous school district leaders who offer strong recommendations and testimonials for the likely efficacy of First in Math, multiple independent researchers and evaluators have also found **statistically significant improvements in math scores** among those who have used First in Math. For example, WestEd conducted an evaluation of 2412 students in Grades 3-6 and found that it had a positive and significant effect on student scores on the California Standards Test and the California Achievement Test (Flaherty et al., 2005). They also found that students and teachers felt they enjoyed the program, were excited about the game format, were **more interested in mathematics**, and, importantly, were encouraged to try to solve math problems independently, even if not yet covered in class. Such results were mirrored in another case study showcasing how a school implementing First in Math for 15 minutes a day was able to become a leader in their district on the Goals Index and see nearly a 33 percentage-point gain in the number of fourth-grade students who scored proficient and advanced on their state's standardized assessment (Columba, 2020).

In conclusion, the evidence-based features of the First in Math program support significant short-term and long-term outcomes for students, teachers, and administrators alike. Students benefit from **increased math proficiency, engagement, self-efficacy, and reduced anxiety** in math, while teachers enjoy a classroom with more engagement and fewer disruptive behaviors. Administrators note tangible improvements in standardized test scores and tool utilization. These outcomes pave the way for students to develop enhanced computational thinking skills, a heightened interest in math, and an increased likelihood of pursuing math-related STEM careers, ensuring a brighter educational future for all involved.

"We have an entire class of Grand Champions! These 20 students worked so hard to reach this goal and they supported, encouraged, and celebrated with each other. It was amazing to witness the teamwork and positive energy of these 10- and 11-year-old students. Additionally, First in Math provided them with the opportunity to deepen their number sense and to work at the intermediate levels. Fact fluency has greatly increased, and they are no longer anxious about word problems thanks to "Know and Show". Your program gave them confidence and a tremendous sense of accomplishment as together, they reached the goal they created — to have an entire class of Grand Champions."

Donna McGough
5th Grade Teacher

Logic Model for First in Math

PROBLEM STATEMENT

Focus: First In Math aims to build K-8 student proficiency in math fundamentals and to reduce their math anxiety, both well documented problems in research and practice. The program accomplishes this through using 200+ simple games that increase in complexity based on performance to practice key principles learned through direct instruction in short videos (<3 minutes). In addition to games, students are able to set goals, choose their focus areas, and in some games, work collaboratively.

RESOURCES

What resources are or could be available?

Product Level Features:

- Simple and effective math games that progress in complexity
- Indirect feedback with scaffolding
- Micro learning content with direct instruction and math strategies (VIFs Module)
- Pre-post assessments of math facts
- Recognition on task completion
- Goals Index: Goal setting and monitoring dashboard

System level inputs:

- Dedicated time to build math proficiency
- Teacher comfort, belief, and understanding of math games and their efficacy in education
- Access to a 1:1 device, such as a laptop or chromebook
- Access to the internet

STRATEGIES & ACTIVITIES

What will the activities, events, and such be?

Students:

- Set their goals in the Goals Index, in collaboration with teacher
- Select grade-level modules, based on teacher guidance, through the Focus Mode
- Choose games within targeted focus areas
- Learn and practice math by playing games that (a) match the intended goal (e.g., math fluency, automaticity, problem solving, computational thinking) and (b) increase in complexity based on performance
- In a number of games, students receive feedback and scaffolding
- Receive automatic skill badges and award certificates on task completion
- Participate in additional math challenges through bonus games and Exclusive 24® Game online content

Teachers:

- Set their goals in the Goals Index, in collaboration with students
- Review the easy-to-use Curriculum Connections & Correlations tool which maps the First In Math games to grade-level standards.
- Select games by grade, standard, and focus area based on goals set
- Decide the duration of practice, i.e. no required dosage
- Support students by encouraging students to stretch themselves or provide instruction when students struggle

OUTPUTS

What are the initial products of these activities?

Students:

- Practice targeted math skills
- Receive immediate feedback
- Progress toward more complex math concepts and problems
- Remain on-task for the duration of practice
- Monitor growth toward goals on Goals Index

SHORT-TERM AND INTERMEDIATE OUTCOMES

Students experience:

- Increased amount of time on task during math practice
- Higher levels of demonstrated growth in math proficiency (fact and procedural fluency, automaticity, and problem solving)
- Higher levels of math self-efficacy.
- Increased competence in computational thinking
- Greater interest and motivation to engage with math learning
- Lower math anxiety

Teachers experience:

- A more engaged math classroom
- Fewer off-task or disruptive behaviors

Administrators see:

- Increased scores in standardized math assessments
- Greater utilization rates of tool

LONG-TERM OUTCOMES AND IMPACTS

- Higher rates of high school graduation
- Higher proportion of students taking and succeeding in Alegbra
- Greater interest and motivation to pursue math and math-informed STEM career pathways

ASSUMPTIONS

- Students are able to intuitively understand how to play the game and are able to recognize the underlying math phenomena
- Administrator support of game-based math programs for supplemental instruction and practice.
- Student's focus goals are integrated and aligned with the in-person math curriculum for the state
- Students pay attention to their response options in time-constrained games and learn from indirect feedback

First in math®

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LXD RESEARCH ESSA Level 3 Evidence

EFFICACY STUDY SUMMARY 2022-2023

Product Description

The First in Math (FIM) online program, a unique math teaching tool for students K-8, delivers substantive and comprehensive mathematics content, from addition to complex algebra, in a game format. Including more than 240 digital mathematics games and modules, the program has been used by more than 20 million students worldwide.

STUDY DETAILS

Sample Size

6 classrooms in grades 3-5 (approx. 150 students) in one school was compared to 8 other schools

Demographics of FIM School

- 92% non-White
- 96% free/reduced lunch
- 30-40% multi-lingual learners

Usage Description

15 mins/day from 2:45-3pm as part of over three school years after school

Methodology

- Standardized (PSSA) test scores were compared between cohorts who had used First in Math and those who did not.
- School board test scores were measured between the treatment schools and 8 other schools.

Study by Lynn Columba from Lehigh University
Mathematics Teaching Research Journal, Spring 2020 Vol 12, no 1, p. 45-57

SCAN TO SEE THE FULL STUDY

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STUDY SUMMARY

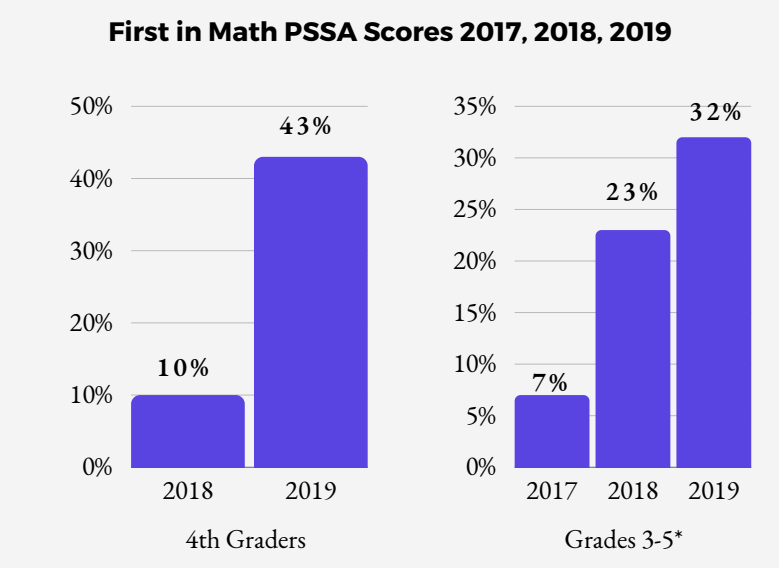
Students demonstrate many of the component parts of computational thinking skills in a variety of disciplines, such as mathematics, science, and computer science education. Computational thinking is an approach to problem solving--the primary purpose for learning mathematics--that can be implemented with a computer (Barr & Stephenson, 2011). This study by Lehigh University explored the effects on students' mathematical development when they engage daily with the First in Math (FIM) online program. The results indicated that 3rd-5th graders using the FIM in an encouraging environment, showed significant improvements in their mathematics achievement.

KEY FINDINGS

The treatment school went from being the lowest performing school in the district on the school board assessment, to the highest, across all domains, including math fact fluency, procedural fluency, and word problem fluency.

First in Math school outperformed comparison schools by 33% and were 25% more likely to be proficient on state exam.

In 2018, only 10% of Marvine Elementary School fourth-grade students scored Proficient and Advanced on their PSSA tests in mathematics. In 2019, 43.9% of the school's fourth graders were able to reach those critical PSSA benchmarks, demonstrating a 32.9% percentage-point gain in the number of fourth-grade students able to score Proficient and Advanced over the previous year.



*These are estimates for the precise numbers were not provided in the paper.

LXD RESEARCH
ESSA Level 3 Evidence

EFFICACY STUDY SUMMARY 2004-2005

Product Description

The First in Math (FIM) online program, a unique math teaching tool for students K-8, delivers substantive and comprehensive mathematics content, from addition to complex algebra, in a game format. Including more than 240 digital mathematics games and modules, the program has been used by more than 20 million students worldwide.

STUDY DETAILS

Sample Size

- 2,412 students in grades 3-6 across 10 schools in a southern California district
- 238 students were surveyed
- 9 teachers were interviewed

Demographics of FIM School

- 46% ELL
- 9% Learning Disabilities
- 12.5% Gifted

Usage Description

Usage varied widely across schools and grades, with use during class, recess, after school, or at home. Average usage was 2.5 hours, while 12.7 hours was the average for those who finished the 8th level (algebra).

Methodology

California Achievement Test (CAT 6) and California Standards Test (CST) in math was analyzed with usage and progress data.

Study by John Flaherty, Brooke Connolly, June Lee-Bayha
WestEd, June 2005
Funded by the U.S. Dept of Education

SCAN TO SEE THE FULL STUDY

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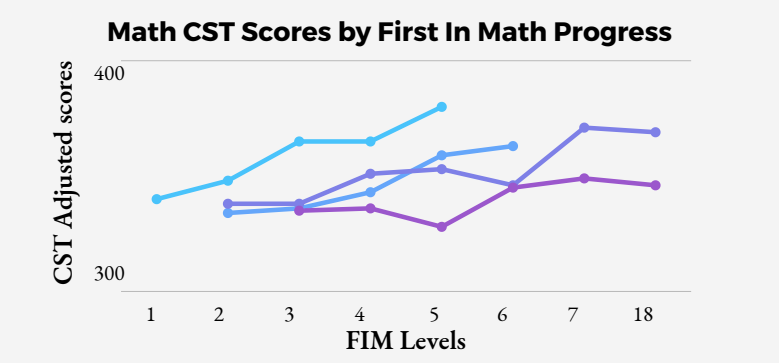
STUDY SUMMARY

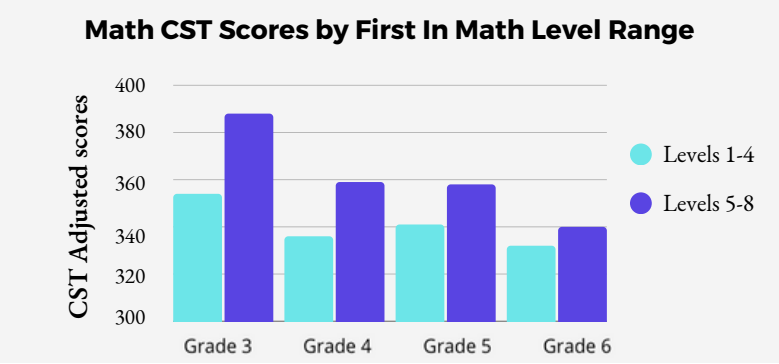
This study used a multi-methods approach to evaluating First in Math. Program efficacy was evaluated by comparing the achievement of students in the study with state averages and by measuring the correlation between product usage and Math achievement. Students worked on their leveled activities most of the time. Surveys and interviews revealed that students enjoyed the program. First in Math helped teachers extend learning time and motivated students to improve their skills.

KEY FINDINGS

- Increased usage was the most impactful factor in First in Math (FIM) level completion.
- FIM use had a significant and positive correlation with all grades on CST scores(.03-.11) and CAT/6 (.05-.08).
- FIM students out performed state test averages for grades 3, 5, & 6, but not 4. On average, their gain was .85 points.



Students who advanced to higher levels in First in Math had significantly higher scores than 3rd-5th graders in lower levels.



Note: Adjusted scores reflect that the analysis controlled for student demographics. Levels displayed reflect 90% of students, based on grade -appropriate content)

LXD Research is an independent research firm that evaluates educational programs with ESSA-aligned methods.

Learn more at www.lxdresearch.com

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