Monster Math

Research Foundation & Logic Model

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RESEARCH-BASED DESIGN ESSA IV

DEMONSTRATES A RATIONALE

LXD Research Recognition for Monster Math

Monster Math

This product has been rigorously evaluated and is hereby acknowledged for meeting the educational impact criteria of the Every Student Succeeds Act (ESSA), warranting a **Level Four** for **"Demonstrating a Rationale."** This recognition is based on its proven effectiveness in enhancing grade-level learning outcomes.

REVIEWED BY THE LXD RESEARCH EXPERT REVIEW PANEL

Rachel Schechter, Ph.D. Founder of LXD Research	April 13, 2026 **DATE**

Understanding ESSA Evidence

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Educators search for high-quality research and evidence-based interventions to strengthen grant applications, to support comprehensive and targeted schools, or to implement new programming in their schools. Evidence requirements 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.

Educational programs document their evidence of design, effectiveness, and impact in order to be eligible for federal funding. While there is no singular authority that determines a program's tier, 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 (Tier 1), moderate (Tier 2), and promising (Tier 3) evidence of effectiveness, or demonstrates a rationale to be effective (Tier 4).

This product meets the requirements for Tier 4:

- ✓ Documentation of how the product's design relates to intended outcomes, with corresponding academic, published research
- ✓ Describes the product's features and outcomes in a logic model
- ✓ A study is planned and/or currently underway
- ★ A third-party research organization has reviewed the documentation for ESSA validation

RESEARCH-BASED DESIGN ESSA IV
LXD RESEARCH

When product designers leverage learning sciences to design their programs, educators can better target instruction, and students' skills soar. Through interviews with the product designers, an evaluation of their research-informed activities, and a planning of an efficacy study, this product meets the criteria for LXD Research's ESSA Tier 4 Evidence.

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

Foundational Research Summary

What is Monster Math?

Monster Math is a digital, game-based learning program designed to improve math outcomes for kids in grades 1 to 3. The program targets three critical areas: math fact fluency, conceptual understanding, and student engagement. It is available as a web and mobile app.

Inspiration Behind Monster Math

K-3 elementary students often struggle to master basic arithmetic facts. Traditional approaches that just emphasize memorization of math facts have often failed to produce the intended retrieval outcomes, particularly under high-demand standards (Baroody, Bajwa, & Eiland, 2009; Henry & Brown, 2008). Another problem is the increasing prevalence of Math Anxiety (OECD, 2024). Around 40% of 15-year-old students in OECD countries reported feeling nervous, helpless, or anxious while solving mathematics problems or doing homework, meaning that students are anxious simply dealing with the subject and not just because they are worrying about failing. Math anxiety (MA) has been described as a feeling of tension and anxiety that interferes with the manipulation of numbers in a wide variety of ordinary life and academic situations (Richardson & Suinn, 1972), and it represents an obstacle to mathematical development. Research indicates that math anxiety is associated with reduced use of advanced problem-solving strategies and lower performance, particularly when working memory resources are strained (Ramirez et al., 2016; Beilock & Carr, 2005). Practitioner guidance cautions that speed-focused practice may contribute to these conditions during strategy development (Bay-Williams & Kling, 2019).

To address these issues, Monster Math's design is grounded in learning science research and evidence-based practices - using visual models, explicit strategy instruction, a low-pressure learning environment, and gamification. The program provides a **calm, gamified learning environment** – free of high-pressure timers – where students progress through an adventurous story while practicing math. By incorporating visual models, narrative context, and strategy-based practice, Monster Math aims to build fluency and understanding **without** the detrimental stress often associated with timed drills (Bay-Williams & Kling, 2019).

This research-informed approach constitutes a strong rationale for the program's effectiveness, aligning with **ESSA Tier IV** criteria (Demonstrates a Rationale) by explicitly linking design features to educational research. Below, we detail Monster Math's key design principles and their research base, followed by a logic model illustrating how these inputs and activities are expected to produce meaningful short- and long-term outcomes for students.

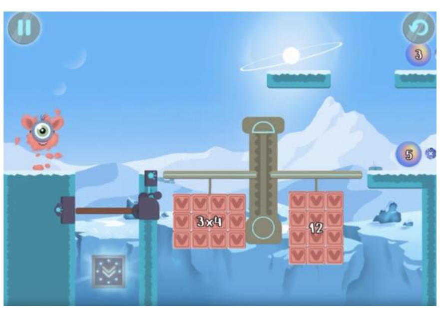
Research-Based Design Principles

Visual Models to Build Conceptual Understanding

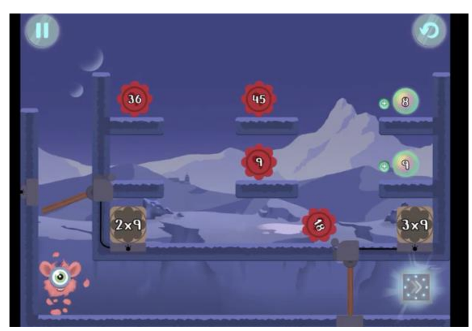
A distinguishing feature of Monster Math is its use of **visual representations and models** for mathematical operations before moving to abstract symbols. When a new concept or fact family is introduced, the game presents it with visual aids – for instance, showing manipulatives, number lines, or bar models illustrating an addition or subtraction scenario.

(This grade 3 puzzle shows multiplication visually using an array representation. On dragging the multiplication power (2x) onto the blocks (the block 3), the block visually expands vertically (into 2 rows) to show the multiplication visually (2 x 3 = 2 rows of 3).

(In this grade 1 puzzle, portals convert abstract representations into visual ones and vice-versa - this helps build a bridge from the visual 10-frames model to the corresponding abstract number notations)



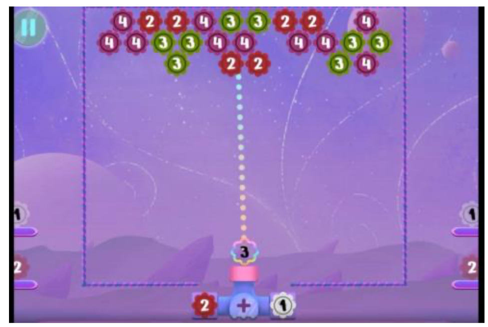
(This grade 3 puzzle visually reinforces the commutative property of multiplication - 3 X 4 is the same as 4 X 3, both are 12)



(This grade 1 level helps kids practice the addition of a group strategy - i.e., adding 9 to 18 to make it 3 x 9)

This visual-to-abstract progression aligns with the Concrete-Representational-Abstract (CRA) instructional framework, which has been shown to support conceptual understanding across multiple mathematical domains, particularly for students with learning difficulties (Witzel et al., 2003; Carbonneau et al., 2013; Milton et al., 2019). While concrete manipulatives need to be in the real world (such as Cuisenaire rods or ten frames), the visual models in the game are “representational” and build on the learner’s previous use of concrete manipulatives - and then slowly transition into “abstract” (use of number symbols instead of visual representations).

Visual models help kids grasp the meaning behind arithmetic operations instead of simply memorizing answers to numeral-based questions. **Research shows that visual representations significantly enhance young learners’ problem-solving success.** In early elementary grades, students who create or are taught to use structured visual representations (such as diagrams or schemas) are more likely to solve math problems, especially word problems, correctly later on than peers who do not use such representations (Fuchs et al., 2021).



(Grade 1 practice with abstract symbols so kids get more familiar with them)

In Monster Math, by combining animated blocks, kids form mental connections that 5 + 2 means putting together 5 objects and 2 objects, for example, and also why 5 + 2 does not equal 8 or 6. This aligns with guidelines from the 2009 panel by the Institute of Education Sciences that recommend using visual representations to build mathematical concepts and support learners, consistent with research linking representations to deeper understanding (Gersten et al., 2009). Research on visual reasoning in arithmetic word-problem solving suggests that structured visual representations can improve comprehension and solution accuracy (Purcar et al., 2024). By consistently incorporating visual models and gradually transitioning to abstract notation, Monster Math ensures that learners don’t just know math facts, but also **understand** them. These digitally shown visual models and animations would otherwise be difficult for a teacher to replicate in the classroom.

Focus on Math Fact Fluency through Strategy Instruction

Monster Math emphasizes **explicit strategy instruction** for basic math facts, rather than rote memorization or drill alone.

First, the focus is on building automaticity with foundational facts (such as for multiplication - multiplication facts of 2, 5, and 10). Once they are proficient at this, it's easier to build the other facts using different strategies, for which there is explicit strategy instruction.

In Monster Math, strategy use is part of the visual problem-solving. These are some of the strategies explicitly covered in Monster Math - Table 1: Strategies explicitly covered in Monster Math.

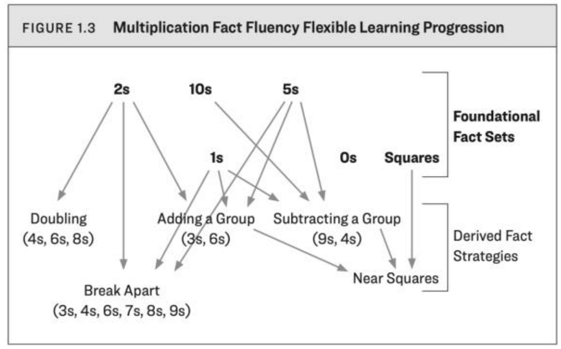
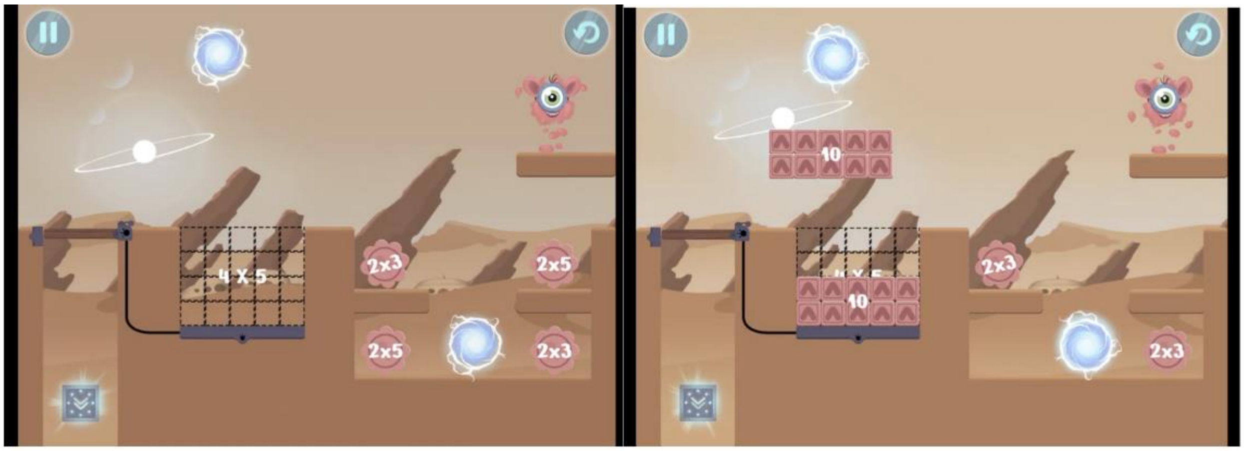


FIGURE 1.3 Multiplication Fact Fluency Flexible Learning Progression

Foundational and derived fact strategies for multiplication. Snapshot from Bay-Williams, J. M., & Kling, G. (2019)

Strategy	For Operation	Example
Doubles	Addition	4 + 4 is a double of 4.
Near doubles	Addition	2 + 3 is nothing but (double of 2) + 1
Make a 10	Addition	8 + 7 is the same as 10 + 5 (moving 2 to the left addend to "make it a 10".
Think addition	Subtraction	15 - 3 can be solved as 3 + ? = 15.
Using 10 as a benchmark	Subtraction	15 - 8 is same as (difference between 8 and 10 plus 5) = 2 + 5
Repeated addition	Multiplication	2 x 3 is the same as 2 + 2 + 2
Adding a group	Multiplication	6 x 7 is the same as (5 x 7) + (1 x 7)
Subtracting a group	Multiplication	4 x 8 is the same as (5 x 8) - (1x 8)
Break apart	Multiplication	7 x 4 is same as (5 x 4) + (2 x 4)
Think multiplication	Division	20 ÷ 5 can be solved as 5 x ? = 20

This approach is strongly supported by research on math fact fluency. Explicit strategy instruction supports meaningful transfer and flexibility in math fact learning (Baroody et al., 2016; Tournaki, 2003). For example, one study showed that students who learned addition facts through strategy instruction not only recalled facts more accurately but also performed better on transfer tasks than students who learned only via rote drill (Tournaki, 2003).



(This level helps kids see the doubles strategy - that 4 X 5 is just 2 times 2 X 5.)

(Missing addends puzzle with explicit nearest-10 strategy, evolving to make-a-10)

Moreover, explicit strategy instruction can improve understanding of the relationships between numbers for many students, fostering **conceptual knowledge** alongside fluency (Baroody et al., 2016; Purpura et al., 2016). According to math education experts, developing fact fluency through strategies and reasoning (often through practice from games and engaging activities) is more effective and equitable than timed memorization drills, which can alienate many learners (Bay-Williams & Kling, 2019). This aligns with widely cited instructional frameworks that define math-based fluency as involving accuracy, efficiency, flexibility, and appropriate strategy use (Bay-Williams & Kling, 2019).

Monster Math's design follows these recommendations by integrating strategy-focused mini-puzzles into gameplay. By doing so, the program builds a strong foundation of strategy use mastery that students can retain and transfer to more complex problems (Baroody et al., 2016; Purpura et al., 2016).

Low-Pressure, Supportive Learning Environment

Unlike many traditional drills or even some educational games, Monster Math deliberately features **calm gameplay with no timers or speed pressure.** This design choice is rooted in research findings that **stress can impair learning**, especially for early elementary students (Ramirez et al., 2016). Timed tests or fast-paced drills may seem to encourage efficiency, but these often have the unintended consequence of provoking anxiety and discouraging students from using advanced math strategies (Bay-Williams & Kling, 2019). Young kids can become so nervous about the clock that their performance suffers, or they begin to develop a fear of math altogether (Ramirez et al., 2016).

Jennifer Bay-Williams and other educators have cautioned that timed fact tests can create negative experiences and beliefs about math that persist (Bay-Williams & Kling, 2019). To avoid these issues, Monster Math's practice sessions are **untimed** and emphasize accuracy and strategy use over speed. Students can take the time they need to think through problems and even use on-screen hints if needed, without the fear of "running out of time." The game's feedback for wrong answers is constructive and encouraging, never punitive. The learners can restart their levels multiple times and attempt the same problem in different ways until they get it right. This low-stress approach creates a **psychologically safe** learning environment, which is particularly important for building confidence in math. Research shows that math anxiety is associated with reduced strategy use and lower achievement, particularly in students with limited working memory resources, suggesting the importance of instructional environments that do not add unnecessary performance pressure (Ramirez et al., 2016). The game is also designed to increase task complexity in an intentional sequence.

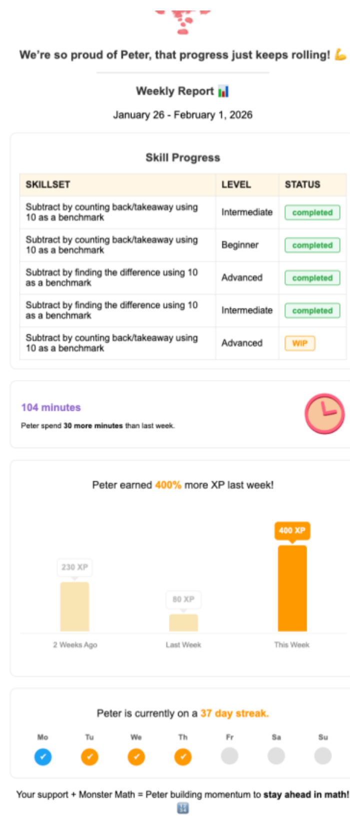
Furthermore, Monster Math includes a supportive narrative context – the child is helping a game character travel through space and achieve goals – which shifts focus away from personal failure and towards **collaborative problem-solving**. By **removing timers and high-stakes pressure**, the program aligns with student-centered, anxiety-reducing practices that have been associated with better attitudes and even improved achievement in mathematics (Ay Emanet & Kezer, 2021). The calm pacing also allows students to **practice perseverance**: if an answer is incorrect, they can try again, potentially applying a different strategy, and thereby learn from mistakes in a safe environment. In sum, Monster Math's low-pressure design ensures that **engagement does not come at the cost of anxiety** – instead, students experience math practice as approachable and rewarding and avoid anxiety, which research indicates is key to sustaining learning gains (Ramirez et al., 2016).

Gamification and Story-Driven Engagement

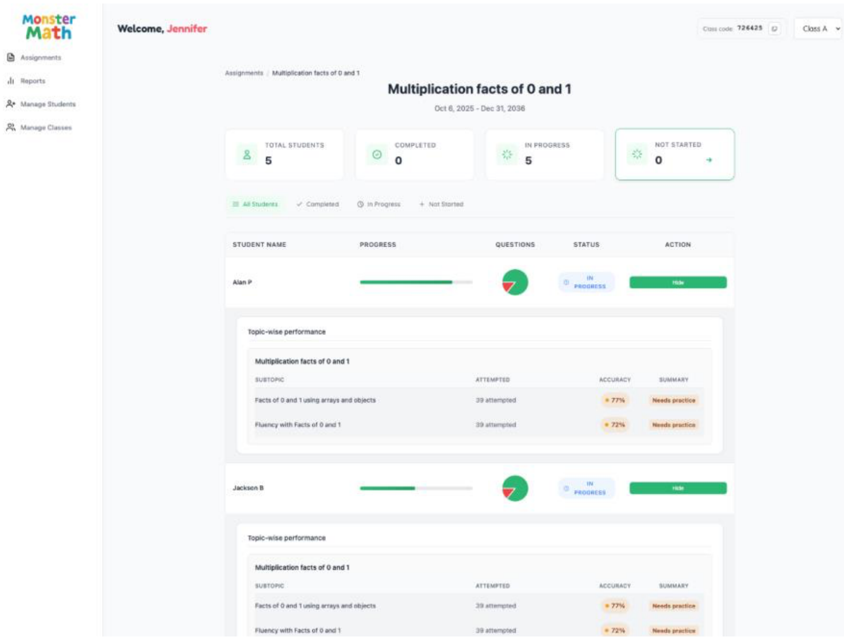
Monster Math harnesses the power of **gamification** to engage and motivate young learners. The program is structured as an adventure story: students help a friendly monster character overcome challenges by solving math problems. This narrative context and game-based reward system (e.g., earning medals and collectibles or unlocking levels) are intentionally designed to sustain interest and make practice enjoyable. The story is designed to make the child curious to know what happens next - and also to care about the character and to want to help them by solving the puzzles. The animations and music are designed to keep kids in a state of "calm excitement" - kids are excited for what comes next, but without high arousal.

Research in educational psychology indicates that embedding learning tasks within a playful, story-rich environment can dramatically increase kids' intrinsic motivation and engagement. In a classic study, Cordova and Lepper (1996) showed that contextualizing math problems within a fantasy narrative led to higher enjoyment and better learning outcomes for students, as opposed to presenting the problems as abstract exercises. More broadly, **game-based learning has been shown to improve both students' motivation and achievement in math**. A recent systematic review reported that the use of educational games in mathematics frequently produces positive effects on learning outcomes (with 21 out of 27 studies showing benefits), and fosters greater interest and motivation in students of grades 1 to 9 (Divjak & Tomić, 2011). Gamification elements such as immediate feedback, progress indicators, and adaptive challenge levels can make practice more engaging and sustain students' involvement over time, and also act as an individualized lesson plan for each child.

Monster Math's calm, cartoonish game world and gentle encouragement for effort exemplify these principles through a story-rich environment, immediate feedback, progress indicators, and adaptive challenge levels. By rewarding persistence with in-app goodies such as medals and in-app wearables and framing math practice as an adventure, the program boosts student engagement – a key ingredient in learning. This high engagement is not just a motivational bonus; it directly supports better learning outcomes. For example, a meta-analysis by Clark et al. (2016) found that digital games have a **significant positive effect on students' learning** compared with traditional instructional methods, highlighting that well-designed educational games can effectively enhance cognitive gains. In summary, the gamified, story-driven design of Monster Math is grounded in the idea (supported by ample research) that engaged learners learn more. By making math practice interactive and narrative-rich, the program captures kids' attention and encourages regular practice, ultimately leading to improved fluency and understanding.



Parent report with positive feedback and friendly terminology is sent as email updates.



Teacher report - Assignment-wise, broken down by students.

Monster Math

Monster Math Logic Model

PROBLEM STATEMENT

Mathematics proficiency has been declining among K-12 students, particularly at the elementary level (National Science Board, 2023). A key driver is weak foundational math fact fluency — students who don't achieve fluency by fifth grade are unlikely to develop it in later grades (Steel & Funnell, 2001; Geary, 2011; Nelson et al., 2016). Early math facts education is therefore critical to long-term math success.

Monster Math addresses this need in grades 1–3 by offering a fun, pedagogy-backed, self-paced solution that builds math fact fluency through explicit strategy instruction. By strengthening early foundations, Monster Math supports not only fact fluency but broader math outcomes in later grades (Nelson et al., 2016)

RESOURCES

What resources are or could be available?

- **Research-Based Curriculum Design :** Grades 1–3 math content framework informed by learning science, including visual models and strategy instruction to ensure developmentally appropriate sequencing
- **Interactive Digital Game Platform**: Child-friendly app/website featuring animations, an engaging storyline, interactive gameplay, and instant feedback to captivate young learners
- **Teacher & Parent Support Tools** : Email progress reports for parents, a dedicated teacher dashboard, and skill assignment features that enable seamless integration into home and classroom practice.

STRATEGIES AND ACTIVITIES

What will the activities, events, and such be?

- **Gamified Practice Sessions**: 15–20 minute puzzle-based math practice with self-paced or teacher-assigned topics to align with classroom instruction
- **Visual & Concrete Representations**: New skills introduced through visual models (arrays, 10-frames, number lines) before transitioning to abstract problems
- **Explicit Strategy Instruction**: Visual demonstrations of key math strategies (e.g., "nearest 10," "adding a group") to build conceptual understanding
- **Immediate Corrective Feedback**: Correct answers earn rewards; incorrect answers prompt additional attempts, reinforcing persistence and improving retention
- **Spaced Repetition**: Mixes new problems with cumulative review of prior content to counteract forgetting over time
- **Story & Reward System** : Adventure storyline with points, badges, and unlocks tied to effort and persistence rather than speed
- **Progress Monitoring & Reporting** : Tracks accuracy, errors, and time-on-task; data accessible to teachers via dashboard and parents via email

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OUTPUTS

What are the initial products of these activities?

- *Students complete more practice problems per week than with traditional methods. This increased* volume of practice is an immediate output of implementing Monster Math.
- Students customize their avatars with rewards and solve more problems to earn additional rewards, thereby increasing engagement.
- Students receive explicit strategy instruction that helps them to develop strong math fact fluency.
- Teachers reduce time spent on assessing where kids stand in math facts and in designing personalized practice.
- Teachers use the reports to identify which areas kids are weak in and where they might need help on a 1-1 basis.
- Repeated in-app practice allows students to achieve mastery.

SHORT-TERM AND INTERMEDIATE OUTCOMES

- **Improved Math Fact Fluency:** Students recall basic addition and subtraction facts more quickly and accurately, using learned strategies rather than blind memorization or finger-counting. After consistent use, students can confidently solve problems like "8 + 7" in seconds by applying strategies such as the making ten strategy, replacing slower approaches like count-all or count-on (Tournaki, 2003; Purpura et al., 2016).
- **Enhanced Conceptual Understanding:** Through visual models and gameplay, students develop deeper understanding of arithmetic relationships — solving novel problems by applying known strategies, indicating transfer of understanding beyond the game context (Baroody et al., 2016).
- **Increased Engagement & Math Confidence:** Students show greater enthusiasm for math, viewing it as a fun challenge rather than a stressful task. Success in the game builds confidence, with students voluntarily practicing and expressing pride in their progress.
- **Reduced Math Anxiety:** By removing timed pressure, Monster Math keeps anxiety low. Teachers may notice less nervousness during class activities and greater participation, consistent with research on game-based practice and self-efficacy (Bay-Williams & Kling, 2019; Hung et al., 2014).
- **Teacher Instructional Adjustments:** Progress data helps teachers identify struggling students by skill, enabling targeted grouping or mini-lessons based on in-game performance.

LONG-TERM OUTCOMES AND IMPACTS

- **Mastery of Grade-Level Math Facts:** Students achieve fluency and conceptual understanding of required facts for their grade level, with built-in spaced review ensuring retention over time (Brown et al., 2014)
- **Higher Math Achievement:** Solid fact fluency and conceptual foundations translate to improved performance on assessments and greater ease with complex math topics (Nelson et al., 2016)
- **Positive Math Attitude & Growth Mindset:** Students develop confidence, persistence, and a math learner identity that reduces future anxiety and supports long-term engagement (Boaler & Greeno, 2000; Ramirez et al., 2016)
- **Equitable Learning Outcomes:** Personalized, multi-modal practice helps narrow achievement gaps, with a higher proportion of students meeting grade-level expectations (Chestnutt, 2025)
- **Foundation for Advanced Mathematics:** Early fluency and conceptual grounding prepares students for multiplication, fractions, and problem-solving in upper elementary and beyond (Nelson et al., 2016; Clark et al., 2016)

ASSUMPTIONS

- Students have access to the necessary technology (computers or tablets with internet connectivity).
- Teachers and parents provide minimal necessary support (encouragement, ensuring usage, and reviewing progress) External factors such as classroom instruction quality, home environment, or individual student needs can mediate outcomes — the model assumes these factors remain conducive (e.g., Monster Math is used as a supplement to quality classroom teaching, not a replacement).

Dear Education Leader,

The **Monster Math** team is grateful for your interest in our platform. We are delighted you chose Monster Math to support your educators and students, knowing that many resource options are available.

We are excited to share our upcoming goal of assessing the efficacy of Monster Math and its impact on academic outcomes, specifically math abilities. To achieve this, we plan to conduct a research study on the product's effectiveness. The findings of this study will help us understand the impact of Monster Math and improve it to serve schools like yours better.

Please contact us to learn more details about the study and the terms of involvement. We hope you'll take advantage of this unique opportunity to help us shape the future of **Monster Math.** If you're interested or have questions, please get in touch with us to arrange a meeting.

Thanks in advance for considering our invitation.

Sincerely,
Roopesh Shenoy
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