hand2mind®

Daily Math Fluency Positively Impacts Students and Teachers

A Research Study

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Mathematical fluency is defined as the ability to perform math problems accurately and quickly. Mathematical fluency is a required component in state educational standards and a critical piece of the foundational math skills necessary for long-term success in math.[1] The K–12 National Math Standards reform grew out of the understanding that students were able to learn mathematics by rote memorization of particular algorithms but could not then apply that knowledge to advanced mathematics. They were lacking overall number sense. The reform addressed some gaps in math instruction; however, math fluency and scores continue to be a struggle for students and teachers alike.

> ***Fluency encompasses more than memorizing facts and procedures. In fact, I believe memorization is one of the least effective ways to reach fluency.***
>
> —Linda Gojak, NCTM President

Research in the last decade revealed that the highest achievers in math are those who focus on big ideas and the connection between ideas. When students have an intuitive understanding that numbers are comprised of other numbers that relate to one another, they possess the foundation needed to conceptualize relationships in numbers and solve more complex mathematical equations and problems. However, the NAEP (National Assessment of Education Progress) project indicated that nationally, on average, 20% of public school teachers from the 4th and 8th grades stated that "lack of adequate instructional resources for mathematics was a moderate or serious problem in 2019."[2]

The question then becomes, now what? What can teachers do to ensure students improve not only their test scores but also their understanding and knowledge of foundational principles in mathematics to set them up for success in the future? *Daily Math Fluency* was developed by hand2mind as a direct result of the gap in math fluency. It provides teachers with a complete toolkit that uses Number Strings, Math Talks, and the most relevant math demonstration manipulatives so they can help their students develop the skills they need to solve mathematical problems and conceptualize the relationship between numbers rather than rely on memorization. A Number String is a set of related math problems designed to teach strategies using number relationships, while a Math Talk is designed to elicit those strategies and provide opportunities for students to reason and make connections in math. An effective fluency routine consists of both Number Strings and Math Talks working together to build fluency in mathematics.

1. https://www.nctm.org/News-and-Calendar/Messages-from-the-President/Archive/Linda-M_-Gojak/Fluency_-Simply-Fast-and-Accurate_-I-Think-Not!/
2. https://www.nationsreportcard.gov/highlights/mathematics/2019/

The Evidence—AMSTI Pilot Project

In September 2019 the Alabama Math Science Technology Initiative, referred to as AMSTI, recruited teachers from across the state to embark on a pilot to examine the efficacy of the *Daily Math Fluency* program in practice. Specifically, the objectives were to gain an understanding of the impact on student knowledge and test scores and to gain insight into the experience of the teachers using the program.

The classrooms and teachers who participated in the program ranged in experience levels and classroom demographic makeup to try to obtain the most holistic view of the impact of *Daily Math Fluency* as possible. All participating teachers were from Alabama, a state that historically ranks low in national math fluency scores. To date, a total of 12 teachers have provided data and information regarding test scores, feedback, and survey responses. Five of those teachers had more than 10 years of experience, three had 5–10 years of experience, three had 3–5 years of experience, and one had 0–2 years of experience. The program consisted of the following:

- *Daily Math Fluency* was piloted in 20 classrooms for the 2019–2020 school year, with 12 classrooms providing complete data and anecdotal feedback.
- Teachers were provided with a grade-level *Daily Math Fluency* kit and received webinar training on the program to provide guidance on the use and expectations.
- Supplementing the quantitative data, teachers conducted weekly small groups with a subset of students and recorded observations throughout the course of the **10 weeks** in the pilot study.
- Teachers also participated in a survey that focused on their experience with the program as well as their observations and feedback on the impact the program had on students.
- Date was submitted for 171 students from 12 teachers and included 1st, 2nd, 3rd, and 4th grade.

Student Impact

Over 200 students participated in the pilot; however, complete pretest and posttest data was submitted for **171 of those students** and is represented in the data summary below **(Table 1)**. The program's efficacy was evaluated using a pretest and posttest design. Before program instruction, students were given a program-agnostic, grade-level fluency assessment. This assessment measured overall fluency skills and was designed to capture the impact of *Daily Math Fluency* on grade-level assessments outside of the program. Upon completion of the 10-week pilot the same fluency assessment was administered to students, and both sets of data were analyzed to measure overall gains.

Table 1: Summary of Gains by Subgroup

Subgroup	Disaggregation	Sample Size	Average Percentage Point Gain
Gender	Male	87	20.1
	Female	78	24.1
	Not Reported	6	NA
IEP	IEP	36	24.4
	Non-IEP	130	21.5
	Not Reported	5	NA
Free/Reduced Lunch	Free or Reduced Lunch	92	21.4
	Paid Lunch	55	19.3
	Not Reported	24	NA
Race	Caucasian	76	20.1
	African American	57	20.1
	Hispanic	19	29.8
	Other	12	30.8

The results of the comparison of pretest to posttest scores demonstrate a significant gain as a result of *Daily Math Fluency*. The average pretest score was 44.5% and the average posttest score was 66.9%—an increase of 22.4% on average in just 10 weeks. Over 85% of participating students demonstrated gains during this pilot project.

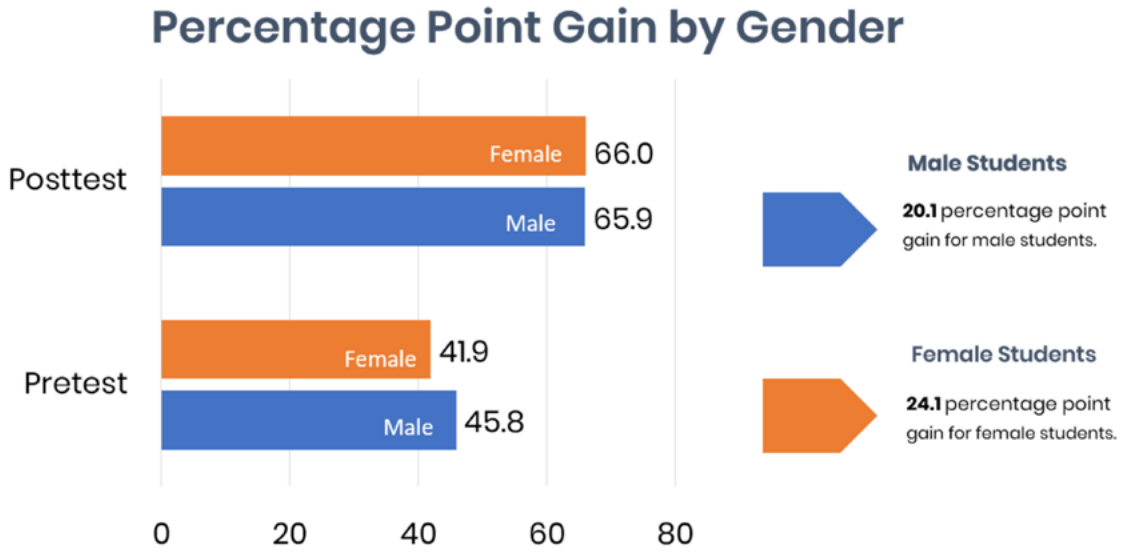
In addition to analyzing the overall pilot data, various subgroups were explored further. The most significant findings are summarized below in relation to gender, IEP profile, and race.

Results by Gender

Based on the most recent data from the NAEP project, nationally, fewer females (38%) were at or above proficiency in math than male students (44%). This data is consistent with other standardized test findings across the country. Additionally, female students did not achieve any gains in proficiency between 2017 and 2019, scoring 38% in both years while male students saw a 2% gain between those two years.[3] In the AMSTI pretests and posttests, female students demonstrated a larger percentage point gain (+24.1%) than males (+20.1%) and surpassed the male students in the average absolute posttest score, although they initially scored lower on the pretest. While males have historically outscored females on math assessments, this data shows that quality fluency instruction decreases the gender gap and, in some cases, overcomes the gap entirely.

3. https://www.nationsreportcard.gov/mathematics/nation/achievement/?grade=4

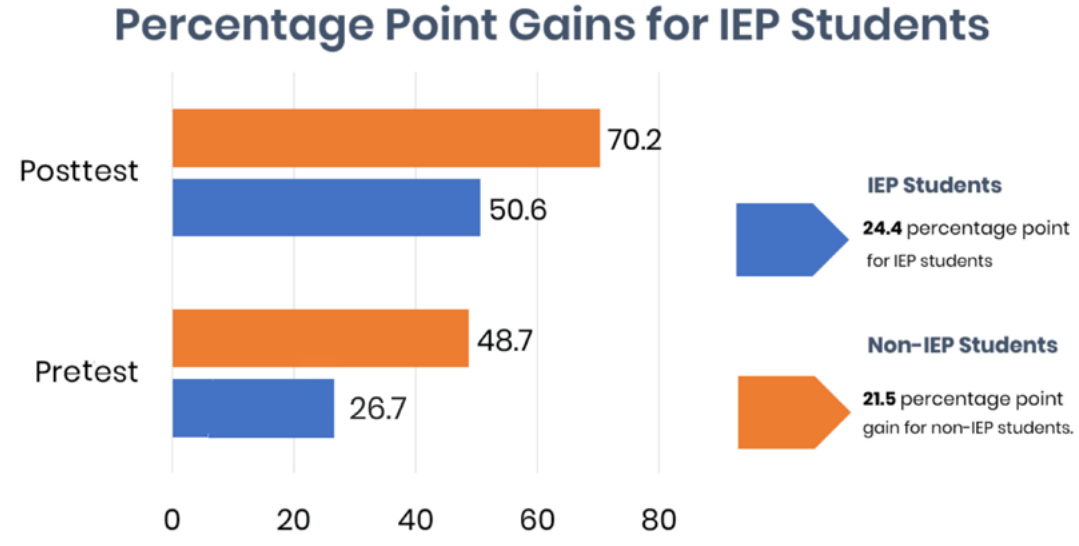
Table 2: Summary of Gains by Subgroup



Results by IEP Profile

Individualized Education Plan (IEP) profiles were explored further as well. When students have an IEP they receive specific accomodations from every teacher in relation to the goals set forth in their plan. Due to challenges in learning they often have lower proficiency than those students without an IEP as can be seen in Figure 2. Of the total students participating in the AMSTI pilot, 21% had an IEP and the average test score gain was 24.4%, compared to the average gain among non-IEP students of 21.5%. These results indicate that *Daily Math Fluency* increases achievement for all learners and enables students with learning challenges to bridge the gap with their peers. While the IEP students are not yet at the same level as their non-IEP peers, the study suggests that if *Daily Math Fluency* is implemented for a longer period of time, the gap could be further reduced.

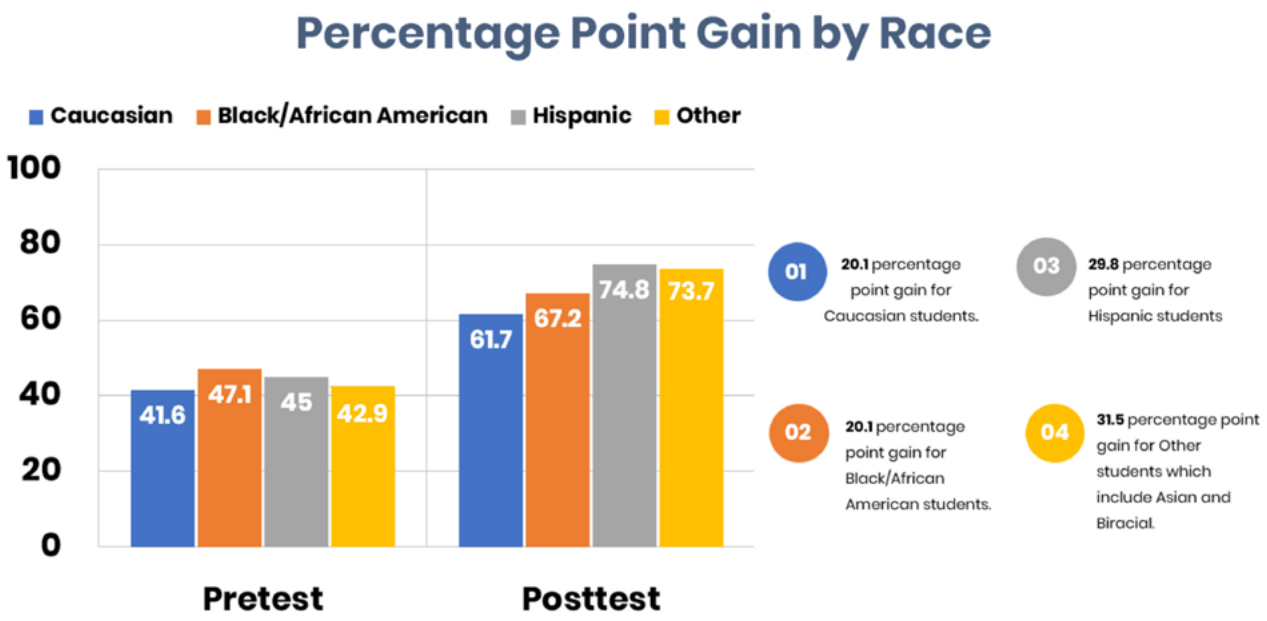
Figure 3: Gains by IEP Status



Results by Race

The most significant findings in relation to race are the increases across all groups. Students who had lower pretest scores showed similar gains as those students with higher pretest scores. Both the Hispanic and "Other" segments showed even higher gains, although it should be noted each had a small sample size (n=19). This indicates that *Daily Math Fluency* provides beneficial instructional support for all students regardless of their proficiency level and suggests that *Daily Math Fluency* is accessible and equitable for students from various backgrounds.

Figure 3: Gains by Race



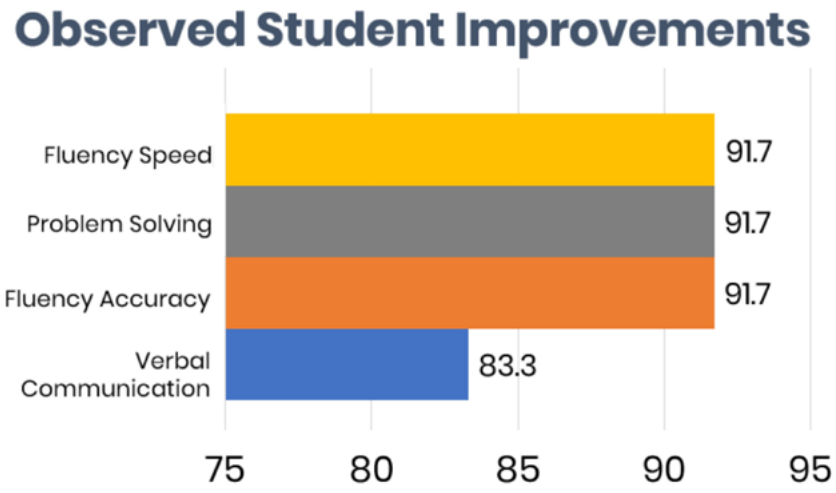
Teacher Observation

The improvement and impact of *Daily Math Fluency* was noticeable to teachers as well, with 100% of those participating reporting that either some (33.3%) or most (66.7%) of student fluency test scores increased.

When asked which components students demonstrated improvements in, 92.6% of the teachers stated fluency accuracy, 91.7% stated fluency speed and problem solving, and 83.3% stated verbal communication in math.

Demonstrating improvements in accuracy, speed, communication, and problem solving are essential for an effective program but are not the only criteria. Motivation to learn and the learning experience are also critical. Teachers in the pilot observed the evolution of student behavior and motivation during the pilot study with 83.3% of teachers reporting that students learned new strategies in math with the program. Also notable is that 75% of teachers reported students were excited about this program and were more engaged in math when this program was used.

Figure 4: Improvements Observed by Teachers



Teacher Experience

The success of a program cannot be based on test scores alone. The ability and ease with which a program can be used, by teachers from all experience levels, is critical in the implementation of a new program.

Of the 12 teachers, on a scale of 1 to 5 in the ease of use of *Daily Math Fluency* (with 1 being very difficult and 5 being very easy), the average response was a 4 out of 5. Additionally, 100% of the teachers reported they liked the program, and 83% would recommend the program to other educators.

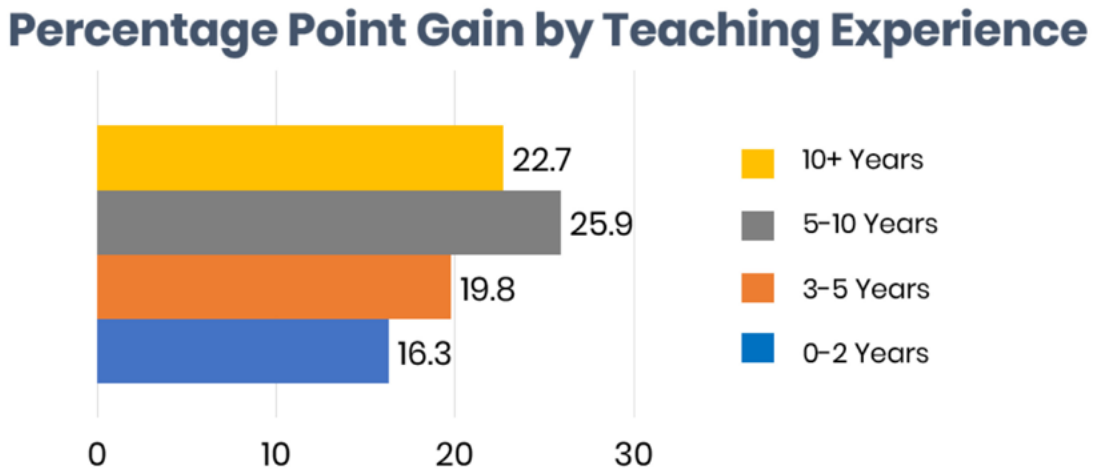
> ***I believe Daily Math Fluency is an engaging routine that all math teachers should be implementing. One of these programs should be followed every day in a math classroom!***
>
> **—AMSTI Teacher**

Qualitative feedback from teachers highlighted their positive experience with *Daily Math Fluency*. They commented on the ease of use, the ability to integrate *Daily Math Fluency* into any curriculum, and the enjoyment of students in the program. One teacher mentioned, "I thought the program was easy to use. I think it would be great for a new teacher. You can just open it and begin." Another teacher stated, "I love that this program comes with all components needed to implement. That makes the program easy to use with any existing curriculum."

Daily Math Fluency is intended to be a program that can be implemented across teacher experience levels, and the feedback obtained through this pilot project supports this concept. The test scores of students disaggregated by teacher experience provides insight into usability across experience levels.

There was little variance in the percentage points gained by students regardless of the experience level of the teacher. It is worth mentioning that there was only 1 teacher participating in the pilot project who had 0–2 years of experience, making those results directional.

Figure 5: Gains by Years of Teaching Experience



However, in looking at the average percentage points gained, there is no evidence that the more experience a teacher has the greater the impact on average test scores. There are likely other variables and factors impacting the gain in test scores, and this is an element to be studied further in future projects and assessments.

Conclusions

The AMSTI Pilot Project provided valuable information on the efficacy and use of *Daily Math Fluency* in the classroom. The evidence from the pilot demonstrates that the program provides support for students to increase their understanding and ability to comprehend mathematical concepts. There is also evidence of the positive impact on students who are most vulnerable—those who scored lowest in math proficiency in the pretest phase of the pilot. Most notable, the improvements in student achievement and observed impacts on learning occurred in just 10 weeks. With *Daily Math Fluency*, teachers of all experience levels, with minimal training, can begin implementing a routine that will positively impact their students immediately.

Teachers participating in the AMSTI *Daily Math Fluency* pilot believe there is a need for effective fluency instruction in every classroom and were eager to share the positive changes in their students as a result of implementing this routine. All students need a strong foundational number sense in order to be successful with higher-level mathematics. The results of this pilot indicate that *Daily Math Fluency* helps students develop critical thinking skills, strengthens their understanding of numbers and how they work together, and builds confidence in learners.