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FASTT MATH® NEXT GENERATION

EVIDENCE & EFFICACY

RESEARCH FOUNDATION PAPER

FASTT Math NEXT GENERATION
Research Foundation Paper

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INTRODUCTION

In the twenty-first century, solid mathematical skills are a prerequisite for school achievement and success in the workplace. Although national mathematics achievement has improved, many students still lack basic mathematical skills. According to the 2011 National Assessment of Educational Progress (NAEP) results, 60 percent of fourth graders and 65 percent of eighth graders performed at or below the Basic level in mathematics (National Center for Education Statistics, 2011). Additionally, analysis of NAEP trend data suggests that the computational skills of American children are in decline (Loveless & Coughlan, 2004). Not only is the national data touted as cause for concern, but comparisons between the students of the United States and their same-aged peers in other countries regularly show US students are not as mathematically proficient.

Given this data and the multiple reasons mathematics achievement is important, it should be expected that prominent national mathematics education experts would point to the necessity of children developing fluency with basic facts. These basic math facts are often defined as number combinations, taken from the set of single-digit whole numbers (0–9) or from 0–12, and their results after performing a mathematical operation (Van de Walle, Karp, & Bay-Williams, 2010). For example, the National Council of Teachers of Mathematics (NCTM, 2006) describes quick recall of and fluency with addition facts, multiplication facts, and related facts with the inverse operations as focal points for the mathematics curriculum in the elementary grades. The recently released the new more rigorous standards for mathematics also indicate the importance of students' fluency with the basic facts (NGA Center & CCSSO, 2010). The authors list fluency with whole-number operations as a critical area of focus in the elementary grades, and many of the grade-level standards call for fluency with math facts (see Table 1 for specific examples).

Further, the authors of the new standards point to the need for procedural fluency in describing the Standards for Mathematical Practice. Similarly, the National Mathematics Advisory Panel (NMAP, 2008) describes computational proficiency as dependent on the development of automatic recall of basic mathematics facts. The authors of the aforementioned documents stress the same important idea: *Today's children must develop fluency with the basic facts*.

At the heart of the difficulty to engage with complex mathematical processes is the given condition that all human beings have limited cognitive resources available at one time. That is, an individual's mind cannot focus on multiple tasks at once. However, when aspects of a task become routine, to the point where they are automatic, one can then focus on other components of the task at hand (Whitehurst, 2003). The implication for mathematics is that some foundational mathematical ideas, particularly basic facts, need to be developed to the point that they are completed automatically. In fact, early development of number ideas has been shown to impact children's mathematical achievement in later elementary grades (Jordan, Kaplan, Ramineni, & Locuniak, 2009). Further, educators and cognitive scientists agree that the ability to fluently recall basic math facts promotes the attainment of more sophisticated math skills (Baroody, Bajwa, & Eiland, 2009; Kilpatrick, Swafford, & Findell, 2001; NMAP 2008; Resnick, 1983), such as rational number and algebra concepts—vital foundations for the study of higher mathematics (Loveless & Coughlan, 2004; NMAP, 2008; Resnick, 1983; Reys, Lindquist, Lambdin, & Smith, 2010).

Table 1. Common Core State Standards Requiring Procedural Fluency (NGA Center and CCSSO, 2010)

Grade	Domain	Standard	Skill
1	Operations and Algebraic Thinking	6	Add and subtract within 20, demonstrating fluency for addition and subtraction within 10.
2	Operations and Algebraic Thinking	2	Fluently add and subtract within 20 using mental strategies. By end of Grade 2, know from memory all sums of two one-digit numbers.
2	Number and Operations in Base Ten	5	Fluently add and subtract within 100 using strategies based on place value, properties of operations, and/or the relationship between addition and subtraction.
3	Operations and Algebraic Thinking	7	Fluently multiply and divide within 100, using strategies such as the relationship between multiplication and division. By the end of Grade 3, know from memory all products of two one-digit numbers.
3	Number and Operations in Base Ten	2	Fluently add and subtract within 1000 using strategies and algorithms based on place value, properties of operations, and/or the relationship between addition and subtraction.

OVERVIEW OF *FASTT MATH* NEXT GENERATION

FASTT Math Next Generation uses the FASTT system (Fluency and Automaticity through Systematic Teaching with Technology) developed by Dr. Ted Hasselbring, noted researcher at Vanderbilt University. This instructional model is based on nearly two decades of research on the development of students' mathematical fluency. For instance, a study described by Hasselbring, Lott, and Zydney (2006), describes three groups of students matched for age, sex, and race. Two of the groups consisted of students struggling with school mathematics, and the remaining group consisted of learners who were not struggling. In the experiment, one of the groups of struggling learners (Experimental) received an average of 54 ten-minute addition sessions with the FASTT system. The other two groups, Non-Struggling Learners and Struggling Learners (Contrast) received only traditional fluency instruction delivered by their classroom teachers. The experimental group gained, on average, **19 new fluent facts**. The contrast group gained no new facts, and their non-struggling peers gained only 7 new facts. Similar results were found when the study design was replicated with the other mathematical operations.

The intention of *FASTT Math* Next Generation is to promote students' abilities to retrieve basic math facts from memory, both accurately and fluently. Students are able to use numbers efficiently, accurately, and flexibly when they have fact fluency (Russell, 2000a). Through the identification and remediation process provided by *FASTT Math* Next Generation, students develop the understanding and skills necessary to automatically recall the result of operations with the whole numbers 0–12. Through a technology-driven, adaptive program of systematic instruction and practice, *FASTT Math* Next Generation helps students abandon the use of inefficient strategies for determining the results of basic number combinations and promotes student automaticity with basic math facts.

The *FASTT Math* Next Generation Student Dashboard is designed to promote students' executive functioning and awareness of their progress related to their effort. This information is provided through easy-to-use features in the dashboard. These features clearly indicate for students which facts are fluent facts, the facts for which they are nearing fluency, and the facts they must learn. Students can also see the increase of fluent facts over time and relate that improvement to the effort they have exerted—a critical link to students' development of productive achievement goals and motives (Dweck, 2002). Using the dashboard, students can clearly discern the number of rewards and trophies they have earned while playing the practice games incorporated in the program.

Games are a vital part of *FASTT Math* Next Generation. They are used to practice newly learned facts and to extend the learning of mathematics. The STRETCH-To-Go games incorporate aspects of the new standards beyond basic math fact fluency. As students play in this STRETCH-To-Go environment they gain opportunities to understand inverse relationships, recognize unknowns, and apply mathematical properties. Specifically, this aspect of the software links students' fluent facts to related computations with multiples of ten. For example, if 3 + 8 is a fluent fact, then the STRETCH-To-Go games could include computations such as 30 + 80 as well as 80 + 30, relating meaning for the commutative property with a fluent fact.

The new Teacher Dashboard provides anytime, anywhere access to essential student usage and performance data. This information is valuable for managing implementation and learning which students may require interventions. The Dashboard Data Snapshots allow teachers to link students' fact fluency to the relevant new standards. Further, teachers can identify students' fluent and non-fluent facts with notifications received describing students' progress. The new Leadership Dashboard provides maximum transparency into the implementation data that matters the most to administrators. Leaders can easily access individual school, grade, and class data to monitor implementation and performance.

FASTT MATH NEXT GENERATION INSTRUCTIONAL MODEL

FASTT Math Next Generation delivers targeted, differentiated instruction to meet each user's needs. Every user has a unique individualized learning experience, building fluency at the pace and level adapted specifically for that student. The program reaches this goal by beginning with a placement assessment. *FASTT Math* Next Generation is able to identify exactly which math facts need to be targeted for each student. The facts students have learned and those still to be automatized are always clearly viewable by students, teachers, and administrators.

The instructional model progresses systematically and adapts the daily instruction to the facts students need to learn. The program incorporates visual models of the facts to strengthen fact automaticity. The instructional model also incorporates independent practice games. These games are designed to engage and motivate while providing opportunities for students to improve fluency by practicing the relevant facts. Throughout the focused instruction and the practice games, the software continuously assesses the students' progress. Along the way to achieving procedural fluency, students are rewarded with trophies and customizing options. STRETCH-To-Go games are a powerful extension of the instruction, designed to incorporate aspects of the new standards beyond basic math fact fluency. For example, as students play in this STRETCH-To-Go environment they gain opportunities to understand inverse relationships, recognize unknowns, and apply mathematical properties. In the next section, the mathematics education literature and relevant foundational research from other disciplines all leading to the development of fact fluency are described. The literature to support these research foundations is then aligned to the key features of *FASTT Math* Next Generation.

FASTT Math Next Generation is informed by an extensive body of empirical and theoretical research on best practices for developing math fact fluency. The following sections provide descriptions of relevant mathematics education, educational psychology, and instructional design research alongside descriptions of how these research foundations have been translated into the program design and curriculum. The relevant categories are:

- ❑ Developing Math Fact Fluency
- ❑ Targeting Instruction and Practice to Build Declarative Knowledge
- ❑ Linking Number and Language to Optimize Memory
- ❑ Utilizing Technology to Improve Students' Affective Learning and Experience

The fact grid provides a clear, ongoing representation of students' fluent, focus, and study facts.

Developing Math Fact Fluency

RESEARCH & EXPERT OPINION

- Students must develop familiarity with number operations and quick and accurate recall with basic facts as a foundation for computational fluency (NMAP, 2008; Russell, 2000a; Russell, 2000b).
- Students who acquire connections among mathematical ideas, which aid in retention of knowledge, have developed knowledge that can then be used to recall learned facts (Hasselbring et al., 2006; Miller & Hudson, 2007).
- Fluency with basic facts occurs through meaningful practice, involving the development and reinforcement of patterns and relationships among number combinations (Brownell, 1956; Baroody, 2006; Baroody et al., 2009).
- The learning of math facts generally moves through a potentially tedious progression characterized by early mistakes and leading to processes that are more capable and less error-prone (Ashcraft, 1992; Fuson, 1982, 1988, 1992; Kilpatrick et al., 2001; Siegler, 1988).
- Subtraction and division facts tend to be more difficult to acquire than addition and multiplication facts, respectively. The links to the inverse operations are useful for aiding students in acquiring fluency with the new facts (Van de Walle et al., 2010).
- Fact fluency occurs at the culmination of the developmental progression. Following the development of meaning for number operations and effective and efficient strategies for finding the results of number combinations, repeated exposures to these strategies assist children in developing automaticity for practiced facts (Fosnot & Dolk, 2001; Van de Walle et al., 2010).
- While we are born with innate arithmetic abilities that allow us to recognize small quantities and then to perform rudimentary addition or subtraction as infants, young brains are not equipped to memorize facts (Dehaene, 2011).
- Multiplicative reasoning is more complex than additive reasoning because it requires a qualitative change in a student's thinking (Van Dooren, De Bock, & Verschaffel, 2010), in which a set of objects is understood to be a unit itself (Kamii, 2000).
- Young students' addition strategies typically begin with direct modeling using objects or fingers to represent each of the quantities, putting them together, and counting all the objects; a "counting all" strategy, and proceed along a progression involving the use of more advanced "counting-on" strategies (Fuson, 1992; Garnett, 1992; Kilpatrick et al., 2001; Verschaffel, Greer, & De Corte, 2007).
- Students with mathematics difficulties struggle to develop the number sense necessary to build number relationships, thereby impeding their abilities to learn facts at a level that makes their recall automatic or accurate (Fleischner, Garnett, & Shepard, 1982; Geary et al., 2009; Hasselbring, Goin, & Bransford, 1988; Torbeyns, Verschaffel, & Ghesquière, 2004; Vaidya, 2004).

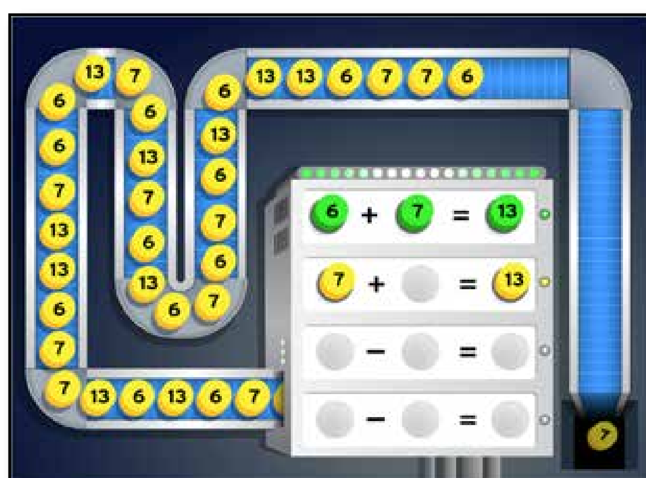
RESEARCH & EXPERT OPINION (continued)

- Although struggling learners may be able to develop the procedures necessary to solve problems involving single-digit number combinations, their inability to develop declarative fact knowledge negatively impacts their future mathematical development (Gersten, Jordan, & Floo, 2005; Hasselbring et al., 2006), and as they grow older, they fall further and further behind their peers in the ability to recall basic math facts from memory (Hasselbring et al., 1988) as well as in the development of higher-order math skills (Loveless & Coughlan, 2004).

FASTT MATH NEXT GENERATION DELIVERS

The *FASTT Math* Next Generation materials include software that assists students in developing fact fluency for the four basic mathematical operations from 0–9 to 0–12. Following the initial placement assessment and throughout a user's experience with *FASTT Math* Next Generation, a fact grid (see p. 7) is provided allowing the student (and teacher) to see the fluent ("Fast") facts and those that the student answered slowly or incorrectly ("Study" facts). Through an adaptive program of systematic instruction and practice, *FASTT Math* Next Generation helps students abandon inefficient strategies for determining the results of basic number combinations and promotes the development of automaticity with basic math facts. The program accelerates and fosters the developmental progressions leading to fluency as described by mathematics education researchers. As a result of the development of math fact fluency, children create the number foundation necessary for performing higher-order mathematics.

The STRETCH-To-Go games found in *FASTT Math* Next Generation also promote the development of fact fluency. This aspect of the program extends students' understandings through meaningful practice with facts for which students have developed or are acquiring fluency. These games extend the students' fact knowledge to multi-digit computation in order to improve procedural proficiency.



The games in FASTT Math *Next Generation provide an engaging context for students to enhance their knowledge of math facts.*

Targeting Instruction and Practice to Build Declarative Knowledge

RESEARCH & EXPERT OPINION

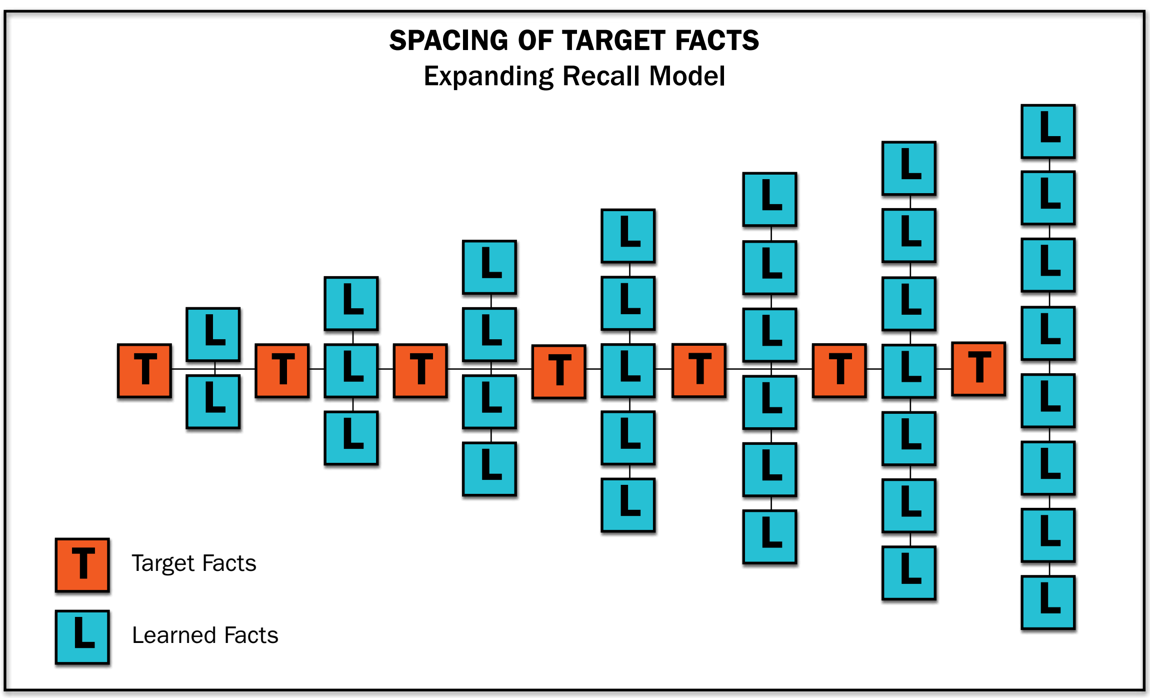
- Students who struggle with developing mathematical ideas need instruction that aids them in strengthening their understanding of fundamental mathematical ideas (Burns, 2007).
- Declarative knowledge involves knowledge of facts and events, such as knowing that 5 + 7 = 12 or 12 - 5 = 7 (Hasselbring, Lott, & Zydney, 2006).
- Declarative knowledge is recalled from memory immediately (Miller & Hudson, 2007), making it a necessary component for fact fluency.
- Researchers (c.f., Hasselbring et al., 1988) suggest that it is best to work on developing declarative knowledge for number combinations by focusing on a very small set of new target facts at any one time.
- Drill and practice have been shown to be effective only with facts that have already been learned (Hasselbring, Goin, & Sherwood, 1986; Hasselbring et al., 2006; Van de Walle et al., 2010).
- Practice involving basic facts should be purposeful, focusing on making reasoning strategies more automatic, not on drilling isolated facts, which is less effective (Baroody, 2006; Delazer et al., 2005).
- Following the development of meaning for number operations and effective and efficient strategies for finding the results of number combinations, repeated exposures to these strategies assist children in developing automaticity for practiced facts (Fosnot & Dolk, 2001; Van de Walle et al., 2010).
- Fluency with basic facts occurs through meaningful practice, involving the development and reinforcement of patterns and relationships among number combinations (Brownell, 1956; Baroody, 2006; Baroody et al., 2009).
- Non-purposeful drill and practice—without the development of number relationships—may cause our brains to create incorrect number associations, which are stored in our memory and recalled when needed despite their inaccuracies (Dehaene, 2011).
- Determining the reaction time necessary to respond to a prompt has been shown to be systematically related to information processing (Posner, 2005), and this factor has had a direct impact on the theory building and empirical validation of cognitive arithmetic, the mental processes and structures necessary for the generation or recall of math facts (Ashcraft, 1995).

FASTT MATH NEXT GENERATION DELIVERS

FASTT Math Next Generation begins with a computer-based assessment that presents all of the number combinations in an operation and records the amount of time that the student takes to evaluate each one correctly. Using a chronometric analysis of the measured latency reaction times for each child's responses—the time difference between typing the number 21 and typing the product when presented with the number combination 7 x 3—the program can accurately determine the facts that are being recalled from memory and those that are solved using a counting strategy.

Following the initial placement assessment, *FASTT Math* Next Generation constructs a fact grid that allows the student (and teacher) to visually see the fluent ("Fast") facts and those that the student answered slowly or incorrectly ("Study" facts). Only after a user is consistently able to retrieve the answer to a target fact within the controlled response time is that fact added to the student's set of drill and practice facts. *FASTT Math* Next Generation systematically builds a memory relationship before it reinforces speed of recall with appropriate drill and practice activities. Additionally the games in *FASTT Math* Next Generation provide opportunities for the necessary practice and review to move along the developmental progression to automaticity of math facts.

FASTT Math Next Generation focuses on a very small set of new target facts at any one time—no more than two facts and their commutative pairs. Instruction on this target set continues until the student has fluent recall of the new facts; i.e., the facts become part of the student's declarative knowledge network. For any fact a student completes incorrectly, the program provides a corrective response, and the student is then prompted to provide the correct response. As students progress with the instructional model, they are always able to access the fact grid to track their progress in relation to the time and effort they have invested with the program.



The model depicts the presentation of non-fluent facts interspersed with a student's fluent facts.

Linking Number and Language to Optimize Memory

RESEARCH & EXPERT OPINION

- Non-purposeful drill and practice—without the development of number relationships—may cause our brains to create incorrect number associations, which are stored in our memory and recalled when needed despite their inaccuracies (Dehaene, 2011).

- As students develop understanding of number combinations through instruction and practice, math fact processing moves from a quantitative area of the brain to one related to automatic retrieval (Delazer et al., 2003)—the declarative knowledge network.

- Through their analysis of fMRI studies, Delazer et al. (2005) noted that, with continued practice, determining the result of a computation no longer requires a process but rather becomes an item-specific retrieval.

- Apart from being foundational to higher-order computation and estimation, automaticity with basic facts allows those facts to move from working memory to long-term memory. Therefore there is greater capacity in working memory to consider more complex mathematics (Baroody, Bajwa, & Eiland, 2009).

- Research has shown not only that exact and approximate computations originate from different regions of the brain, but also that when facts are learned in one language and then required in another, the language centers of the brain are triggered to retrieve the result of a given number combination (Venkatraman, Siong, Chee, & Ansari, 2006).

- Engaging students in learning that encourages the exploration of number relationships helps them develop their mathematical memory, an interconnected web of mathematical ideas that stay with children long-term, even when they are not being continually reinforced (Baroody et al., 2009; Isaacs & Carroll, 1999; Russell, 2000b).

- Previous fMRI studies of math fact recall suggest that automatically retrieved facts are stored in the same region that houses word associations (Dehaene, Spelke, Pinel, Stanescu, & Tsivkin, 1999; Delazer et al., 2004), suggesting a potential linguistic relationship between a number combination (eight times seven, for example), and the result of successfully performing the operation (fifty-six, in this case).

FASTT MATH NEXT GENERATION DELIVERS

The rationale for *FASTT Math* Next Generation is motivated by a focus to free up students' working memory to allow them the cognitive capacity to attend to complex thinking processes. Consider a student who is using an algorithm to perform multiple-digit division. She must monitor constantly where he is in that process. If the student must use primitive counting strategies to subtract or multiply while completing the algorithm, the attention and memory resources devoted to these steps in the procedure reduce the student's ability to monitor and attend to the intended division computation. The result is that the student often fails to grasp the concepts involved in multiple-digit division. However, if the student has developed automaticity for basic math facts, she is able to use her working memory to focus on the task at hand, thereby building understanding for more complex mathematics. *FASTT Math* Next Generation provides this opportunity for its users.

In order to construct a memory relationship between the numerical values contained in a basic fact and the words used to represent those values, *FASTT Math* Next Generation explicitly requires students to type each newly introduced fact. By generating the entire fact, students connect the two elements. Further, if students falter in holding that connection in memory, the program demands that they retype the fact to reestablish the relationship.

Additionally, *FASTT Math* Next Generation develops a user's declarative knowledge network by interspersing two new "target" facts with other already automatized facts in a pre-specified, expanding order. Each time the target fact is presented, another automatized fact is added as a "spacer" so that the amount of time between presentations of the target fact is expanded. This "expanding recall" model requires the student to retrieve the correct answers to the target facts over longer and longer periods.

Once a fact is established, *FASTT Math* Next Generation uses controlled response times to reinforce the memory connection and inhibit the use of counting or other non-automatic strategies, thereby "moving" the fact into the student's declarative knowledge network. A controlled response time is the amount of time allotted to retrieve and provide the answer to the fact. *FASTT Math* Next Generation begins with a controlled response time of 1.25 seconds, forcing students to abandon inefficient strategies and to retrieve answers from their declarative knowledge network.

If the controlled response time lapses before the student can respond, or if the student answers incorrectly, the program provides corrective feedback by presenting the problem/answer relationship again. This continues until the student gives the correct answer within the controlled response time.

Utilizing Technology to Improve Students' Learning and Affective Experience

RESEARCH & EXPERT OPINION

- Results from recent research suggest that technology can contribute positively to student development of number concepts (Mevarech & Rich, 1985; Schoppek & Tulis, 2010; Yang & Tsai, 2010). Utilizing technology as a learning tool inside or outside of the classroom has been shown to improve student dispositions toward mathematics (Ainsa, 1999; Yang & Tsai, 2010) and mathematical self-concepts (Mevarech & Rich, 1985).

- Students' beliefs, attitudes, and emotions—interrelated components that comprise affect (McLeod, 1992; Philipp, 2007)—have been found to influence their mathematical achievement. That is, a student's view of mathematics as a subject of study or a child's view of himself or herself as a doer of mathematics can impact his or her mathematical success (Ashcraft & Kirk, 2001; Fennema, 1989; Hembree, 1990; Schweinle, Meyer, & Turner, 2006).

- In multiple settings research has shown students' achievement goal orientation is mediated by their beliefs about the fixed vs. growth nature of intelligence (Dweck, 2002).

- Technology can change the nature of the mathematics being learned by providing an engaging environment different from what could occur in the regular classroom setting. Not only does technology utilize a gaming environment, which provides intrinsic motivation for learning (Kamii, 2000), but the individualized nature of many programs also addresses specific needs of children (Clements, 2002).

- The use of technology tools as a curricular innovation provides a meaningful context within which students can explore mathematical ideas (Clements, 2002; Mevarech & Rich, 1985; Kamii, 2000); further, using computer games to promote learning allows for a deep, engaging experience during which one's learning can reach optimal effectiveness (Gee, 2008).

- The National Mathematics Advisory Panel (NMAP, 2008) and the Institute of Education Sciences (Gersten et al., 2009) have recommended the use of computer-based programs that assist children in the development of fact fluency and automaticity.

- Just as mathematics is not a "purely intellectual endeavor" (Hannula, Evans, Philippou, & Zan, 2004, p. 109), "learning is not merely a cognitive activity but is affectively charged for students" (Schweinle et al., 2006, p. 288). By providing children with learning opportunities that engage them in the learning of meaningful mathematics, we can help improve their dispositions toward mathematics (Schweinle et al., 2006), thereby increasing student mathematical performance.

- Due to the immediate feedback inherent to many computer programs that support number development, students can work at their own pace on the number combinations with which they struggle (Van de Walle et al., 2010).

- The incorporation of technology tools not only frees working memory for more complex mathematical thinking (Baroody et al., 2009), it also provides an opportunity for improved student outlooks (Ainsa, 1999; Mevarech & Rich, 1985; Yang & Tsai, 2010), thereby improving student performance (Pearce, Lungren, & Wince, 1998).

FASTT MATH NEXT GENERATION DELIVERS

Not only does the program use technology to individualize pacing and target instruction, it also promotes optimal learning and affective experiences in school mathematics. The rationale for *FASTT Math* Next Generation incorporates the power of technology to effectively promote students' automaticity of basic math facts. As students develop automaticity with basic facts, their working memory frees up, allowing them to perform more complex mathematics. As students become more capable mathematically, their beliefs about themselves as doers of mathematics improve, which in turn continues to improve student performance. Therefore, individual engagement with *FASTT Math* Next Generation provides an environment that meets each student at his or her level of need, providing an opportunity to improve each one's mathematical performance and mathematical dispositions.

In addition, *FASTT Math* Next Generation leverages the power of technology to provide a gaming environment. These games allow students multiple opportunities to think strategically and gain additional practice with their learned number facts. The program software also allows for the production of reports and graphics depicting a student's progress as a function of effort. The ability to view how one is improving by investing time and thought promotes a growth mindset. Enabling students to develop an understanding that investing effort leads to learning and "getting better at math" is clearly a primary way to improve students' overall experiences in school mathematics. *FASTT Math* Next Generation is able to use the technological interface to give students, teachers, and leaders access to information describing this improvement.

Conclusion

The major objective of elementary school mathematics should be to develop number sense. Like common sense, "number sense produces good and useful results with the least amount of effort" (National Research Council, 1989, p. 46). Furthermore, number sense serves as the groundwork for important aspects of the mathematics students need for future college and career success (Jordan et al., 2009; Loveless & Coughlan, 2004; Kilpatrick et al., 2001; NMAP, 2008; NCTM, 2000). Therefore, the importance of developing number concepts, including basic fact fluency, cannot be overemphasized.

The use of a computer-based program to assist students in the development of fact fluency has been recommended nationally (NMAP, 2008), and has been shown to be effective (Mevarech & Rich, 1985; Schoppek & Tulis, 2010; Yang & Tsai, 2010). *FASTT Math* Next Generation meets each student at his or her level of need by first assessing the student's basic fact knowledge. Subsequently the program provides opportunities for individualized basic fact instruction and practice that fosters student automaticity of all facts. The development of the users' fluency and automaticity not only frees working memory so students can attend to more sophisticated requirements for thinking, but it also supports their improved mathematics self-efficacy thereby paving the way for students to experience greater successes in mathematics in the future.

In addition to this foundational research on which *FASTT Math* Next Generation was developed, mathematics educators have designated the program a useful tool for student self-monitoring of basic facts. The authors of a popular textbook for the education of future elementary-grades teachers stated, "One good example of available software is *FASTT Math*. This is a diagnostic tool with ongoing assessment. The program is student-paced, provides 'self-progress tracking,' and includes practice games" (Van de Walle et al., 2010, p. 183). Additionally, *FASTT Math* received the 2006 Best Instructional Software in Math CODIE award in the category of Education from the Software & Information Industry Association. The Next Generation of the program maintains the accolade-worthy aspects of the original program and incorporates a contemporary user interface and new fluency games to improve the user's experience and ultimately the opportunities to improve fluency with basic math facts.

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