

# Foundational Research for JFINTV® Lyrical Math

a supplemental math intervention program that uses hip-hop music as a medium to enhance basic math skill performance

EDUTAINMENT IS KEY! 



prepared for the program developer by Educational Research Institute of America (ERIA)



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## INTRODUCTION

*All students need to succeed in mathematics.*

Never before has the workplace demanded such complex levels of mathematical thinking and problem solving on which economic growth, social well-being, and global competitiveness depends. To keep pace with a rapidly changing world and its challenges to individual and national interests, our students need to be prepared for a future in mathematics. (Council of Economic Advisors, 2015; Hanushek & Wöessmann, 2007; Loveless, 2011; National Mathematics Advisory Panel, 2008)

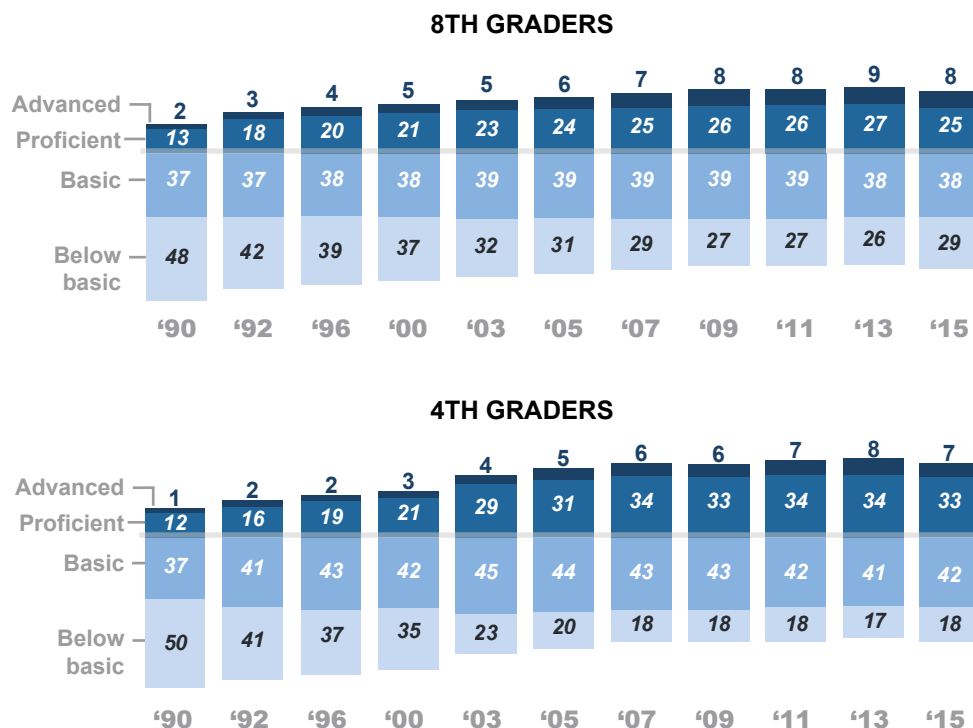
U.S. students rank in the middle among their peers internationally and behind many other advanced industrial nations, placing 38th out of 71 countries on the most recent Programme for International Student Assessment (PISA) in mathematics (Pew Research Center, 2018). Additionally, American students' average achievement level has not improved over the past decade (Organization for Economic Cooperation and Development, 2013).

Within the U.S., 68% of our nation's fourth graders and 66% of our eighth graders do not meet current mathematics standards. Moreover, race, gender, and social class achievement gaps in mathematics persist (U.S. Department of Education, 2017).

It is clear that the United States must improve educational outcomes.

## After years of growth, math proficiency of U.S. students dips

*% at each achievement level of the National Assessment of Educational Progress (NAEP)*



Source: NAEP Data Explorer, National Center for Education Statistics  
PEW RESEARCH CENTER

Source: Pew Research Center, 2018. Retrieved online:  
<https://www.pewresearch.org/fact-tank/2017/02/15/u-s-students-internationally-math-science/>

The National Research Council's 2011 report *Successful K-12 STEM Education: Identifying Effective Approaches in Science, Technology, Engineering, and Mathematics* outlines the following goals for STEM instruction:

- Expand the numbers of students who ultimately pursue advanced degrees and careers in STEM fields and broaden the participating of women and minorities in those fields;
- Expand the STEM-capable workforce and broaden the participation of women and minorities in the workforce; and
- Increase STEM literacy for all students, including those who do not pursue STEM-related careers or additional study in the STEM disciplines.

The NRC report also includes research findings showing what makes for effective STEM education and programs; they:

- capitalize on students' interests and experiences;
- identify and build on what students know; and
- provide experiences to actively engage students in STEM-related practices and sustain their interest.

**“Persistent and unacceptable gaps narrow and ultimately disappear when all students have access to rigorous, high-quality mathematics, taught by teachers who not only understand mathematics but also understand and appreciate learners’ social and cultural contexts in meaningful ways.”**  
-National Council of Teachers of Mathematics, 2014, p. 65)

JFINTV® Lyrical Math is a math intervention program that uses hip-hop music as a medium to enhance basic math skill performance. Lyrical Math builds confidence and mastery for students. The mission is to produce high-quality “edutainment” products and services in hopes of accomplishing two specific tasks:

1. Innovate the student education experience.
2. Be an advocate for personal growth.

JFINTV® Lyrical Math aligns with research findings and principles advocated by specialists and organizations dedicated to improving mathematics teaching and learning. Research support for the program is outlined within this document.

## *What the research says*

### **Music boosts the learning of mathematics**

Connections between music and mathematics date back to antiquity, with discoveries credited to Pythagoras. Active engagement with music has even been associated with improved intelligence (Schellenberg, 2004). However, research had previously found only strong correlations between music and spatial-temporal reasoning and other skills advantageous for high-level cognitive abilities generally and mathematics specifically. More recent advances in brain science have established causal relationships between music and cognitive development (Holmes & Hallam, 2017; Miendlarzewska & Trost, 2014; Rauscher, Shaw, Levine, Ky, & Wright, 1994). Educators have also investigated ways to utilize music to improve K-12 mathematics instruction; findings from these studies indicate that music can have a positive impact on students' achievement within and attitudes toward mathematics (An & Tillman, 2015; An, Ma, & Capraro, 2011; Rauscher & Hinton, 2011).

"Music is an ideal form of art to be integrated in mathematics instruction. The links between music and mathematics are very rich and include melody, rhythm, intervals, scales, harmony, tuning, and temperaments. These musical concepts are related to the mathematical concepts of proportions and numerical relations, integers, logarithms and arithmetical operations and the content areas of algebra, probability, trigonometry, and geometry."

-An, Capraro, & Tillman, 2013, p. 2

#### ***Music enhances mathematics reasoning and instruction***

The experiences of operating melodies, harmonies, and rhythms through music may stimulate mechanisms of the brain that are responsible for mathematic reasoning (Rauscher et al., 1993 & 1997) and in a manner that facilitates capacity to learn representations of number and geometry (Spelke, 2008).

The positive effects of integrating music connections and representations in mathematics may allow students to better understand mathematics from multiple approaches (An & Tillman, 2015; Gardner, 1993; NCTM, 2000).

The effects of music instruction on various aspects of cognition, including mathematics, have been shown to **benefit children from a range of socioeconomic backgrounds** (Rauscher & Hinton, 2011).

Additionally, **motivation, reward and social context accompanying the integration of music within education may be among the long-term benefits to students** (Miendlarzeska & Trost, 2014). An and Tillman (2015) cite studies that have found empirical evidence demonstrating both cognitive and affective benefits of integrating music within mathematics instruction, including engagement in self-reflection and active inquiry (Parsons, 2005); an enjoyable and collaborative learning environment (Robertson & Lesser, 2013) improved motivation to learn math (Glastra, Hake, & Schedler, 2004).

**“We can conclude that bringing music into mathematics classes provided a joyful environment for students. As a consequence, students engaged and effectively strengthened confidence in learning mathematics.” -An, Kulm, & Ma, 2008, p. 107**

### **Dance may further improve learning**

Emerging research suggest that incorporating gestures and movement within mathematics—such as through dance—holds additional promise for boosting learning (Alibali & Nathan, 2012; Riley, Lubans, Holmes, Hansen, Gore & Morgan, 2017). One study in this area, which examined a dance-based strategy that middle school mathematics teachers can use to leverage purposeful sequences of movement and stillness to communicate meaning, supports findings that embodying mathematical concepts through movement improves students’ understanding of certain mathematical concepts and problem solving skills (Leonard & Bannister, 2018).

### **Music improves recall of information**

Empirical evidence supports what many people have directly, commonly experienced: that music aids memory, such as through song lyrics recalled many years later. Indeed, music is a helpful mnemonic device for verbal learning throughout life, especially during early development and in educational settings. Music also enhances learning of non- musical content material for developmentally challenged students. (Calvert & Billingsley, 1998; Claussen & Thaut, 1997; Peterson & Thaut, 2007)

The power of music in learning and memory continues to be explored and harnessed. In a study of individuals with Alzheimer’s disease, it was found that for two groups to whom unfamiliar children’s songs were presented, sung lyrics yielded greater recognition accuracy than spoken lyrics, leading the researchers to conclude that music heightens arousal in patients with Alzheimer’s and allows better attention and improved memory (Simmons-Stern, Budson, & Ally, 2010).

## How Lyrical Math supports the integration of math and music

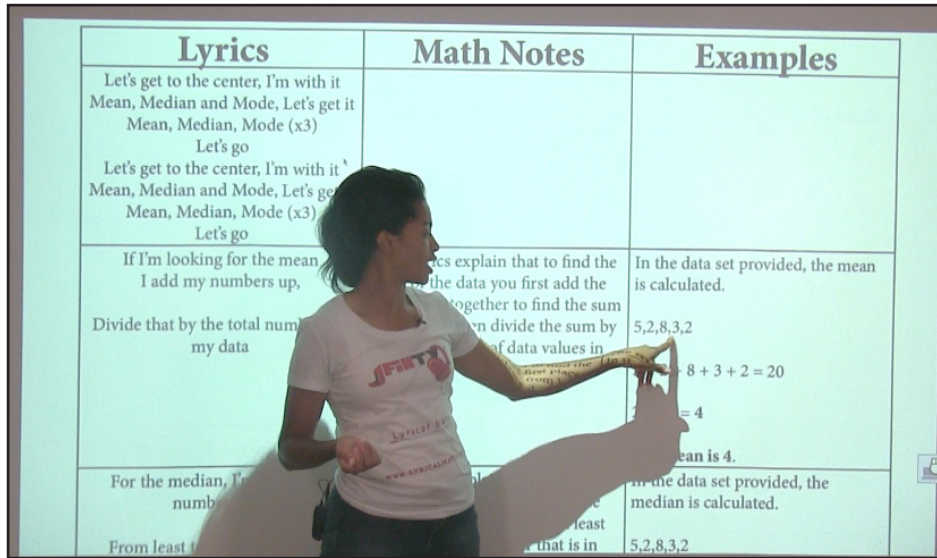
Engaging Hip Hop music is at the core of *JFINTV Lyrical Math*. Each lesson begins with a video featuring an original song that teaches a mathematic concept and accompanying skills and strategies—and helps students retain the information into long-term memory. CDs with the music are also available for review or new learning.



The music serves to spark students' interest in the math concept. Mrs. Finney, half of the pair of program developers, then breaks down the lyrics, explaining line by line the skills and targeted learning behind the music and providing examples. In this way, music fosters understanding.







The program also connects movement and dance to lyrics, video, and mathematical concepts to aid retention and reinforce learning.



JFINTV® is also available for assemblies, to get an entire school singing and dancing—and excited about learning math.



### *What the research says*

## **Procedural fluency is best built from conceptual understanding—and automaticity supports both**

Within mathematics, “procedural knowledge and conceptual understandings must be closely linked” (NRC, 2005, p. 232). This is because understanding of mathematical concepts and procedures develop iteratively—gains in one yield gains in the other (Rittle-Johnson & Alibali, 1999; Rittle-Johnson, Siegler, & Alibali, 2001). Key research and organizations in the field of mathematics education call for an integrative approach to instruction that balances both conceptual understanding and procedural fluency (National Council of Teachers of Mathematics, 2014; National Mathematics Advisory Panel, 2008; National Research Council, 2001).

**“Effective teaching of mathematics builds fluency with procedures on a foundation of conceptual understanding so that students, over time, become skillful in using procedures flexibly as they solve contextual and mathematical problems.”**

—National Council of Teachers of Mathematics, 2014, p. 42

Students need an environment to develop both skills and concepts in order to gain the flexibility required to engage with mathematical ideas and to develop as critical thinkers (Franke, Kazemi, & Battey, 2007). Connecting procedures with underlying concepts aids students in their retention of the procedures and application of them within new situations (Fuson, Kalchman, & Bransford, 2005; NCTM, 2014).

**Underpinning both procedural fluency and conceptual understanding is automaticity, the capacity to deliver a correct answer immediately from memory, without calculation.**

Indeed, as supported by information-processing theory, automaticity in math facts allows for success in many areas of higher mathematics (Baker & Cuevas, 2017; Ball, Ferrini-Mundy, Milgram, Schmid, & Schaar, 2005; Lin & Kubina, 2005). “The value of students being able to access math facts in a timely manner is well established,” (McGee, Brewer, Hodgson, Richardson, Gonulates, Weinel, 2017, p. 259) as it “frees up working memory capacity that then becomes available to address more difficult mathematical tasks” (Pegg, Graham, & Bellert, 2005, p. 50).

**“Developing automaticity is a building block for the success of students in the math classroom.”**

—Baker & Cuevas, 2017, p. 20

Studies suggest that automaticity is a barrier for students struggling with math and a predictor of performance on general mathematics assessments (Stickney, Sharp & Kenyon, 2012). When students lack the ability to retrieve facts directly or automatically, they experience additional processing demand and cognitive load that can lead to procedural errors, diminished number sense, or difficulties in developing conceptual understanding (Woodward, 2005).

Pointing to how learning disabilities in mathematics commonly manifest as difficulty correctly executing computational procedures and how mastery of computational skills is extremely important because of the dependence that more advanced mathematical skills have on such mastery, Manalo and colleagues (2000) call for interventions that develop automaticity—and recommend mnemonic approaches for aiding memory of math facts. Other researchers (Greene, 1999; Nelson, Burns, Kanive, & Ysseldyke, 2013) lend further support to the effectiveness of mnemonics as a way to improve fluency and automaticity within approaches to math intervention programming. It has been found that repetition is another important factor in the process of mastering math facts, with more greater repetition required for students with lower math skills from the outset of intervention sessions (Burns, Ysseldyke, Nelson & Kanive, 2014).

In a 2009 Institute of Education Sciences/What Works Clearing House practice guide (which, as with all of these IES practice guide publications from the U.S. Department of Education, was subjected to rigorous peer review) "Assisting Students Struggling with Mathematics: Response to Intervention (RtI) for Elementary and Middle Schools," Gersten and colleagues identify

**"Results of the study revealed that mnemonic training enhances learning and that the benefits of mnemonic instruction are retained over time. Mnemonic interventions may prove helpful in building foundation skills needed by students with LD for performing more advanced mathematical operations."  
–Greene, 1999, abstract.**

retrieval of basic arithmetic facts as crucial for long-term success and then necessary within systematic instruction and recommend that **interventions at all grade levels devote about 10 minutes in each session to building fluent retrieval of basic arithmetic facts.**

The panel (Gersten et al., 2009) that authored the IES/WWC guide to Response to Intervention practices in mathematics also found that **practice** must be extended until retrieval of math facts becomes automatic and that cumulative **review** is critical for students to maintain fluency and proficiency. The panel also recommends that, particularly for Tier 2 and Tier 3 students, **motivational strategies**, including **praise and rewards**, be incorporated within RtI supplemental instruction:

Many of these students have had experiences of failure and frustration with mathematics by the time they receive an intervention. They may also have a particularly difficult time storing and easily retrieving information in their memories. Therefore, it seems particularly important to provide additional motivation for these students.

Praising students for their effort and for being engaged as they work through mathematics problems is a powerful motivational tool that can be effective in increasing students' academic achievement. Tier 2 and tier 3 interventions should include components that promote student effort (engagement-contingent rewards), persistence (completion-contingent rewards), and achievement (performance-contingent rewards). These components can include praise and rewards. Even a well-designed intervention curriculum may falter without such behavioral supports.

–Gersten, Beckmann, Clarke, Foegen, Marsh, Star, & Witzel, 2009, p. 44

## *How Lyrical Math supports*

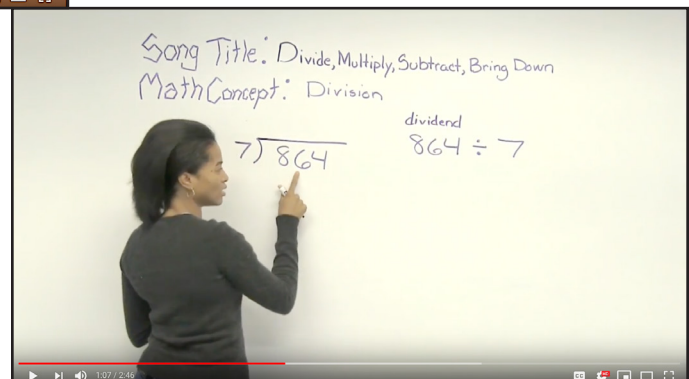
the development of procedural fluency, conceptual understanding and automaticity

JFINTV Lyrical Math is a 20-week enrichment program designed to help students in grade 4 and up master 10 basic math concepts and skills including:

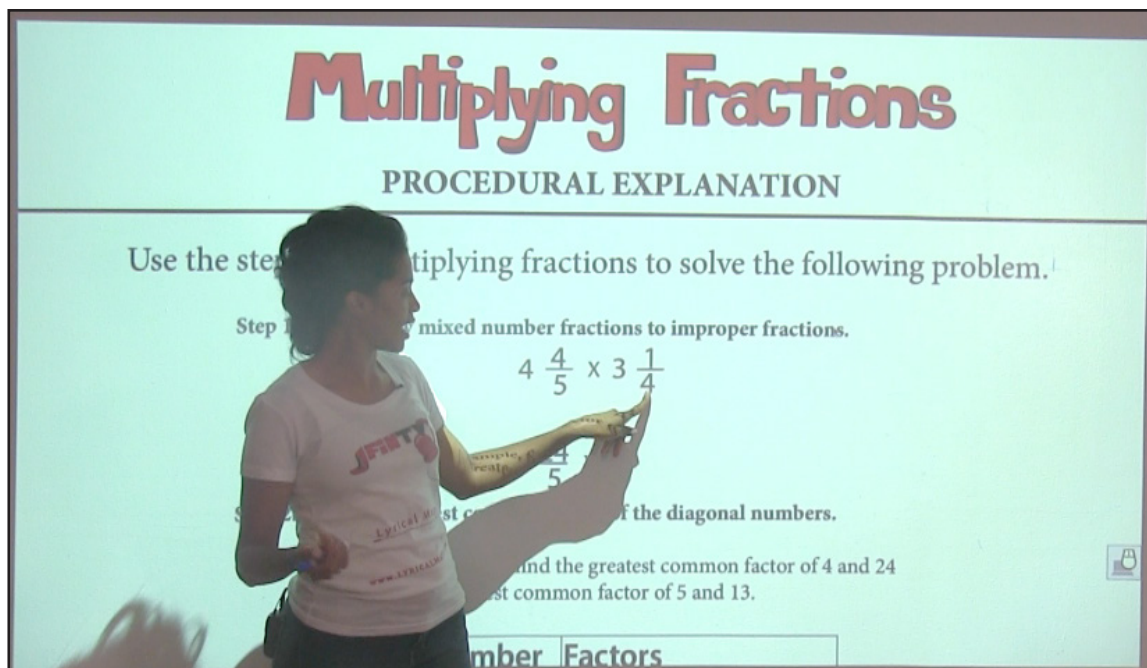
1. Multiplication
2. Division
3. Multiplying Fractions
4. Dividing Fractions
5. Adding Integers
6. Area of 2-Dimensional Figures
7. Conversion of Length
8. Conversion of Volume
9. Mean, Median and Mode
10. Rational and Irrational Numbers

To best support teachers in their instruction of program content, the Lyrical Math program starts with a 1-hour professional development for staff in person or via video conferencing.

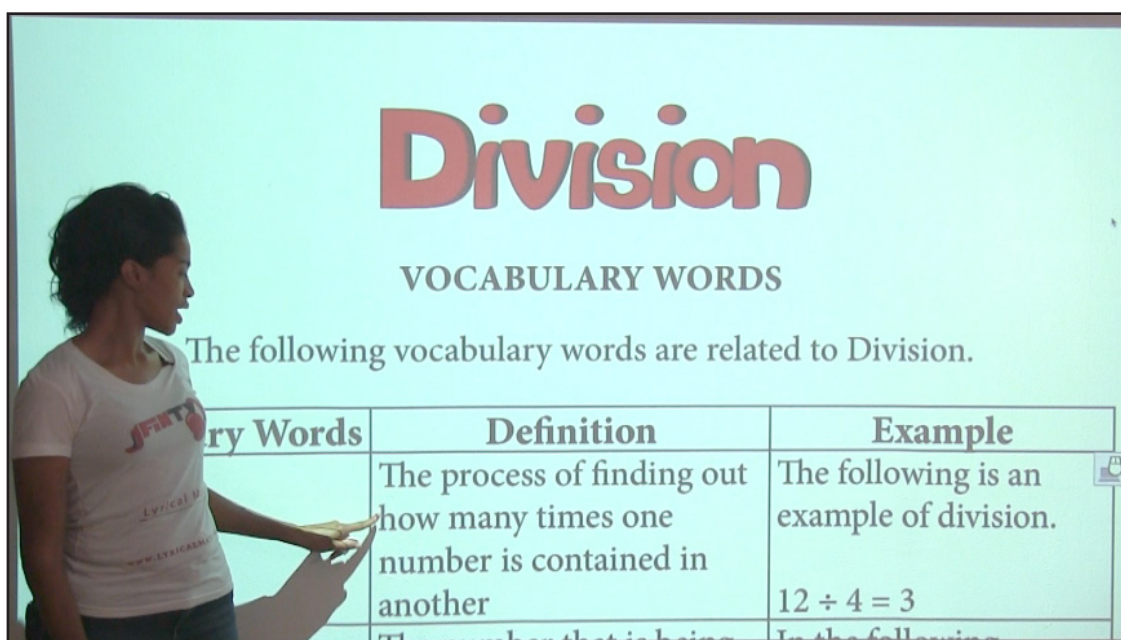
Each concept is developed via an innovative approach that integrates music with math instruction in Mrs. Finney's videos. The lyrics and lesson content are designed to boost fluency with procedures and automaticity.



The lyrics, math notes, and examples pages include detailed explanations of the meaning behind each line in of each song. Mrs. Finney also provides a detailed mathematical explanation and example for the lyrics in each song. She further explains how these lyrics apply to the math strategy used in each lesson.



Vocabulary is taught explicitly to further build conceptual understanding.



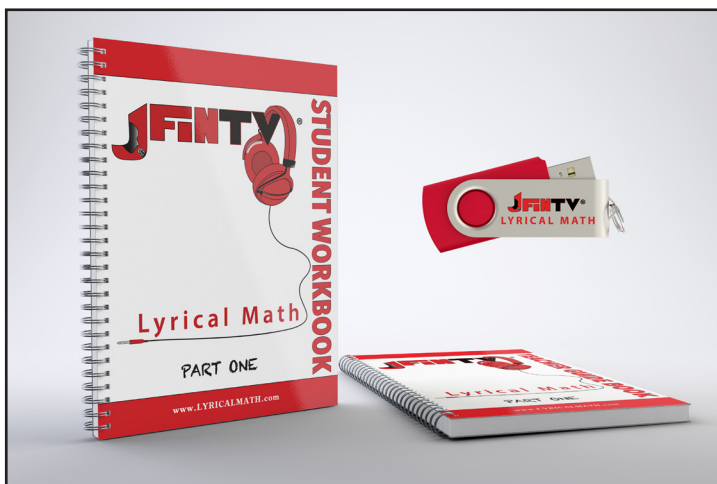
On the procedural explanation page, Mrs. Finney provides a step-by-step explanation of a strategy used to solve the mathematical problems presented in each lesson and helps students understand how to apply strategies to the problems. Students practice how to use the lyrics to complete computations and solve problems.

1) The base of a rectangular music video set is 11 feet and the height is 7 feet. What is the area of the music video set?  
 Area of a rectangle =  $bh$   
 $= 11 \times 7$   
 $= 77 \text{ft}^2$   
 The area of the music video set is  $77 \text{ft}^2$ .

2) The director requested a table to be on set for scene 1 of the music video. It took four production assistants to bring the table on set. The area of this perfectly squared table was 16 square feet. What is the length of the side of the table?  
 Area of a square =  $s^2$   
 $16 \text{ft}^2 = s^2$   
 $\sqrt{16} = \sqrt{s^2}$   
 $4 = s$   
 The length of the side of the table is 4 ft.

3) The stage is shaped like a trapezoid with its base facing the audience. The front of the stage is 13 feet long, and the back of the stage is 17 feet long. The distance between the front and back of the stage is 10 feet. What is the area of the stage?  
 Area of a trapezoid =  $\frac{h(b+B)}{2} = \frac{10(13+17)}{2} = \frac{10(30)}{2} = 150$   
 The area of the stage is  $150 \text{ft}^2$ .

4) The rectangular deck in Bruno's backyard is 18 feet long and 9 feet wide. What is the area of Bruno's backyard?



Each student receives a consumable Lyrical Math Workbook and each teacher receives a scripted Guide Book. This program content builds conceptual development and procedural fluency through additional instruction and practice. Assessment material, in the form of a Book Pretest and Posttest and Pre and Posttests for each lesson, is also included to help teachers evaluate learning and allow for appropriate interventions until each student achieves


mastery. Beyond mainstream classroom instruction effectiveness, Lyrical Math is an ideal component of Response to Intervention, after school, summer, and other supplemental programming to boost skill levels and performance for students experiencing difficulties in mathematics. Lyrical Math utilizes music and dance to aid memorization and mastery of math facts.








Motivation and celebration are key. *Lyrical Math* encourages students in their potential and praises students for their achievements every step of the way, in schools and on social media. Helping students become proud and confident in their capabilities as math learners is a fundamental aim of the program.



**J FINTV Lyrical Math**  
November 16, 2018 · 🌐

Squad Deep! Wrapping up a Lyrical Math Performance with some awesome scholars! I see greatness! LEARNING MATH WILL NEVER BE THE SAME! Lyrical Math Part 1 CDs, Lyrical Math Part 2 CDs, Lyrical Math 20-Week Program, Lyrical Math Live Performances, and more all available through [www.lyricalmath.com](http://www.lyricalmath.com) #lyrical-math #mathematics #mathematicians #mathteacher #mathtutor #mathisfun #math #scholars #hiphopeducation #hiphoped #musiceducation #lyricsoftheday #musicthatmatters #school #homeschool #homeschoolmom #music #rappers #rapperschool #femalemcs #femalemcee #femalemc #blessed ##blackgirlsrock



Upon successful completion of *Lyrical Math*, students are honored in an awards ceremony to recognize and celebrate their accomplishments.



## *What the research says*

### **A growth mindset is essential for mathematical success**

Preparing students for success in math requires changes to some widely and persistently held beliefs about mathematical learning. Mathematics is frustrating and overwhelming to many students in U.S. classrooms. A common refrain among students and teachers both is that one is simply “not good at math.” Society has traditionally valued the math learner who can memorize well and calculate fast, rather than others who possess equal potential but may be deeper, slower, and possibly more creative—and have disserved all students, as all students need to develop mathematically for success in school and beyond. Mindsets have contributed to persistent negative perceptions within mathematics education specifically. (Boaler, 2011, 2016; Dweck, 2008; NCTM, 2014)

**“To ensure that all students have access to an equitable mathematics program, educators need to identify, acknowledge, and discuss the mindsets and beliefs that they have about students’ abilities.”**

–National Council of Teachers of Mathematics, 2014, p. 64

Growth mindset, a concept pioneered by renowned psychologist Carol Dweck (2006, 2008), is a belief that a person’s intelligence, competence, and talents can be developed through dedicated efforts and hard work. In contrast to a “fixed mindset” in which people see their abilities as immutable or whether they possess related intelligence or not, the idea is also linked to attitudes and perceptions regarding success and failure—and the amount of control one thinks he or she has in experiences with either throughout life. It has been found that students with a fixed mindset about math do not see the value in putting forth the effort to learn and that students who struggle, in particular, are more likely to have a negative, fixed mindset toward their own mathematical abilities (Boaler, 2016).

Rattan, Good, and Dweck (2012) point out that instructors with a fixed mindset about mathematical intelligence—even when conscious and well-intentioned in expressing support and encouragement in response to a student’s suboptimal performance—can generate detrimental and long-lasting outcomes for the recipient who may be resigned to accept a presumed lack of ability (e.g. “benevolent sexism”).

A growth mindset within mathematics emphasizes teaching and learning as processes that cultivate mathematical abilities; stresses that success and learning are reflections of effort and not intelligence alone; and promotes a belief that all students are capable of participating and achieving in mathematics (Boaler, 2011, 2016; Dweck 2006, 2008, NCTM, 2014).

Mindsets and the assumptions around them have an enormous impact on students' academic behaviors and achievement and indeed their overall social-psychological well-being (Dweck, 2006; Farrington et al, 2012). Mindsets drive how much effort students devote toward their education and the outcomes of that effort has a recursive effect, perpetuating a positive or negative cycle as results affirm beliefs (Bandura, 1996; Dweck & Leggett, 1988). **Students with a growth mindset are much more likely to persist in their efforts and overcome challenges** (Dweck, Walton, & Cohen, 2011).

Teachers and students both must adopt growth mindsets and positive views on the challenge that is inherent to the process of learning math with understanding, as the belief that effort outweighs aptitude and perseverance through challenging concepts and complex problems yields numerous benefits to students and boosts achievement (Boaler, 2011 & 2016; Dweck, 2006 & 2008; Hiebert & Grouws, 2007; NCTM, 2014; Pascale, 2015).

Fortunately, there is a growing body of evidence spanning decades and fields of research suggests that **mindsets are malleable; that intervention programs can be effective at altering students' perceptions of their own success and failure, and promoting growth mindsets; and that when students are taught to have a growth mindset, they are more successful academically** (Blackwell et al., 2007; Farrington et al., 2012; Yeager & Dweck, 2012).

Rigorous randomized experiments indicate that **even relatively brief messages and activities designed to instill and reinforce growth mindset over several months improved student achievement, including the achievement of low-income and minority students** (Aronson, Fried, & Good, 2002; Blackwell, et al., 2007). Rattan and colleagues (2015) point out that, unlike structural changes, such as to class sizes or curricula, which are expensive and have historically yielded mixed results, **mindset interventions offer a relatively low-cost solution with much potential success: they can boost grades and motivation, particularly among struggling students, and they can reduce racial, gender, and social class achievement gaps.**

Yet, rather than limiting outcomes to quantitative measures of achievement, **schools and classrooms that promote a growth mindset focus on learning and make learning enjoyable** (Yeager, Paunesku, Walton, & Dweck, 2013).

**"The question is not whether all students can succeed in mathematics but whether the adults organizing mathematics learning opportunities can alter traditional beliefs and practices to promote success for all."**

**–National Council of Teachers of Mathematics, 2014, p. 60-61**

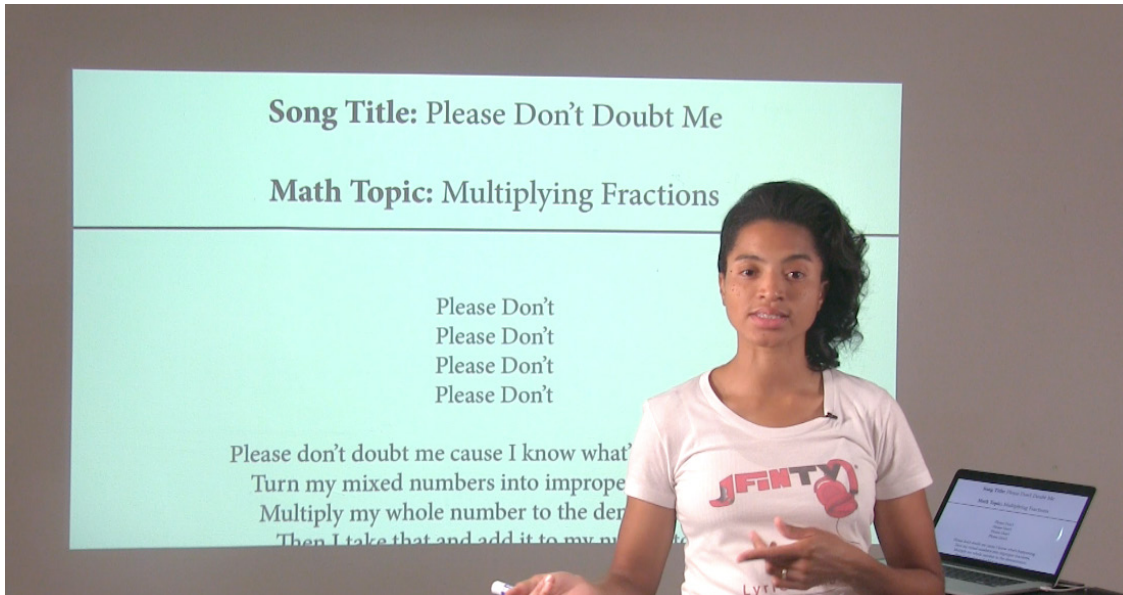
## *How Lyrical Math supports* a growth mindset for all students

A key component of JFINTV Lyrical Math is helping young math learners develop a growth mindset.

In addition to math concepts and skills, lyrics within the program's Hip Hop songs contain positive messaging that assures students that they are all capable lyrical mathematicians and that with hard work and effort they can attain success. Mrs. Finney calls special attention to the lyrics that build students' confidence within the content and context of mathematical learning.

**You know me I'm at the top of my class  
I'm so nice and precise with my math  
They wanna hear my 2's  
They wanna hear my 2's  
They wanna hear my 2's  
They wanna hear my 2's**

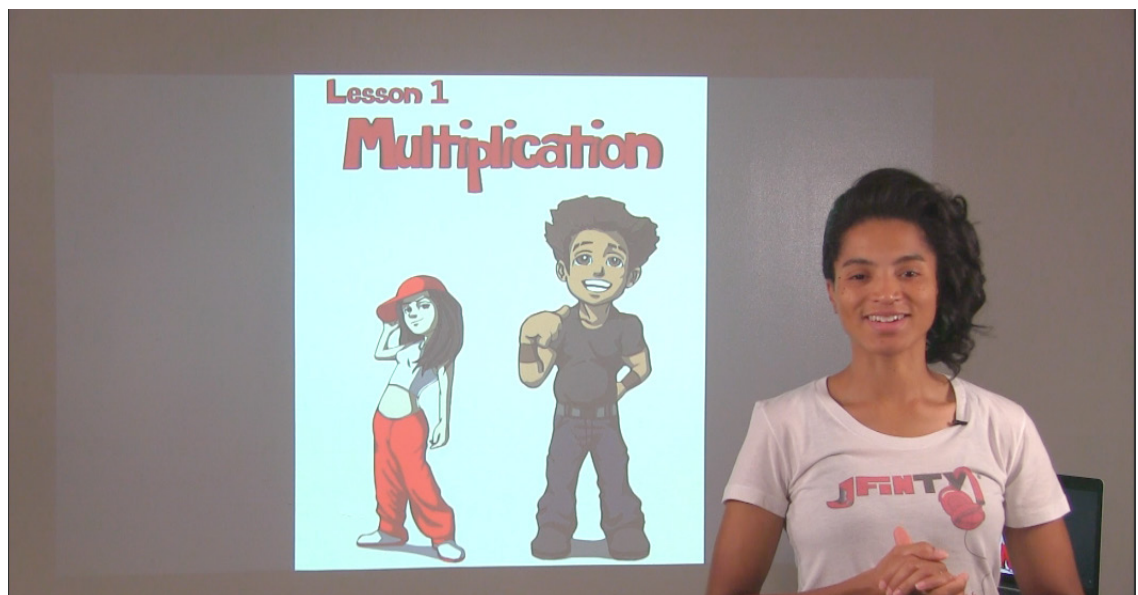




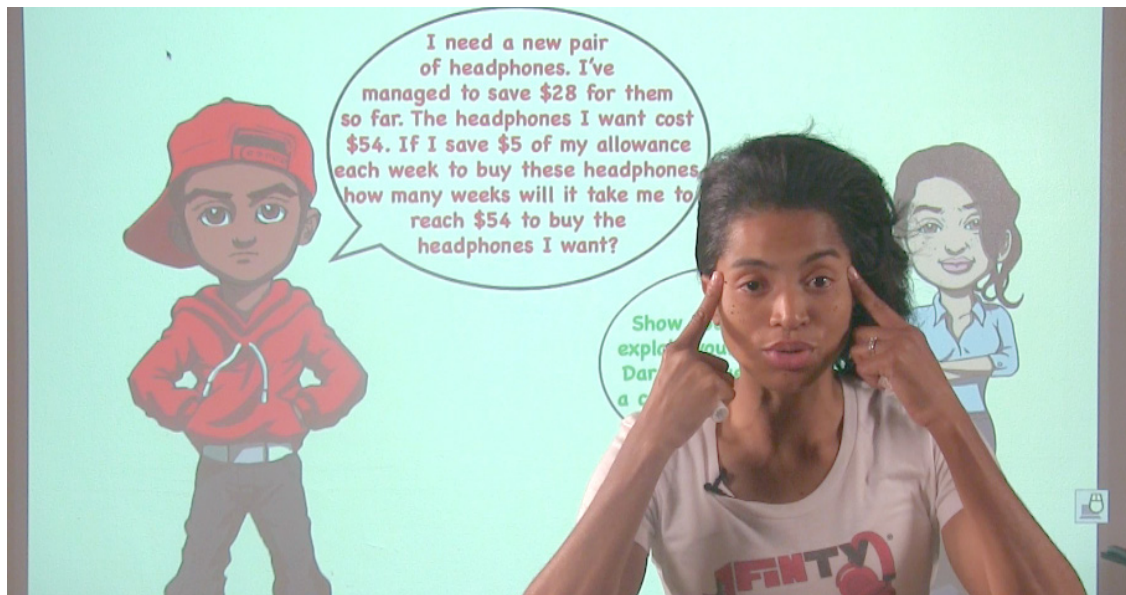
"Please don't doubt me 'cause I know what's happening, Turn my mixed numbers into improper fractions...."

"Never slacking when I take a class, you know I pass that...I'm all about my school work, stay away unless you got a plan to do work."

Lyrical Math also embeds within its mathematics content for each lesson stories and profiles of characters who experience challenges in learning math (and in life) but persevere until they attain success.



The stories are revealed over the course of each lesson. Within the critical thinking activity for each lesson, students are required to solve real world problems using two or more math strategies.



Mrs. Finney reads dialogue of the characters involved in the critical thinking problem and challenges students to find the solution. After students work independently to solve the problem, Mrs. Finney brings the group back together to review the answer—and the outcome for the characters.

These stories provide growth mindset narratives and models for students who can see themselves in the readily identifiable characters and situations.

### *What the research says*

## All students must experience a sense of social belonging within their mathematics instruction

### *What is social belonging?*

"[S]tudents need to feel as though they belong to a community of learners and that their academic self is a "true" self." (Farrington et al., 2012, p. 10) As environmental social contexts, schools have a profound influence on a student's academic self-efficacy and academic self-concept, and serve as a source of models for academic behaviors—both positive and negative (Oyserman, Terry, & Bybee, 2006; Usher & Pajares, 2008).

**Belongingness, or a sense of acceptance within a community, is a basic psychological need associated with multiple benefits. Within a school setting, belonging encompasses academic mindsets, empowering members with entitlement of place through the reinforced belief in one's competence and capacity as a learner.** Belonging to an academic community engenders increased motivation and autonomy that in turn predict engagement and performance. Conversely, social alienation is linked to decreased interest in school and academic achievement and such behavioral problems as aggression and withdrawal (Farrington et al., 2012; Osterman, 2000). **Students will persevere in their efforts to learn and develop more positive attitudes toward peers and teachers, as well as school and the learning process when they feel respected, are treated fairly, and share relevant goals and values** (Farrington et al., 2012; National Research Council, 2004).

### **Issues related to a lack of social belonging**

Minority students in the U.S. face a unique struggle with uncertainties of academic belonging. Pervasive negative messaging—intentional and not—about the capability and worth of students traditionally marginalized by race, ethnicity, and gender has been pervasive and entrenched within schools, leaving large swaths of learners to disentangle their own personal aspirations and narratives from what is known as stereotype threat. **Such stereotype threats adversely impact students' self-perceptions, self-confidence, attitudes toward learning, and academic performance.** Students may fear confirming negative stereotypes about their intellectual abilities, and become anxious or underperform. These stereotype threats cut across socioeconomic and reinforce inequalities and achievement gaps (Farrington et al., 2012; Steele & Aronson, 1995; Walton & Cohen, 2011; Shapiro & Williams, 2011; Yeager, Walton, & Cohen, 2013).

Mathematics is a field of learning historically rife with attitudes and discourse that generate stereotype threat and exclude or otherwise adversely impact a wide range of groups: students from African American, Latino, and urban backgrounds and girls in particular (Flores-Gonzalez, 2002; Gutiérrez, 2013; Martin & Larnell, 2013; Shapiro & Williams, 2011; Stinson, 2006; Walton & Spencer, 2009; Yeager, Walton & Cohen, 2013). Fortunately, **interventions and other measures to foster social belonging and counter stereotype threats have yielded positive outcomes with minimal costs and infrastructure to implement.**

### *Ways to foster social belonging*

Research has demonstrated that students—females and students of minority backgrounds, and in mathematics in particular—are more likely to feel that they belong when academic environments communicate growth mindsets and do not contain stereotypical objects and messages (Cheryan, Plaut, Davies, & Steele, 2009; Good, Rattan & Dweck, 2012).

Minority students who received messaging from older students (of both majority and minority backgrounds) sharing that they experienced initial concerns about belonging that improved over time within the same school context later reported improved feelings of academic fit as well as better GPA over their minority counterparts who did not receive such messages (Walton & Cohen, 2007 & 2011). In another study, information sessions where underrepresented students discussed belonging-relevant experiences later reduced the social-class-achievement gap (Stephens, Hamedani, & Destin, 2014).

**“[M]any of the critical challenges facing racial and ethnic minority students in the formation of strong, positive mindsets for academic achievement can be alleviated through the careful work of creating supportive contexts that provide consistent and unambiguous messages about minority students’ belonging, capability, and value in classrooms and schools.” –Farrington, Roderick, Allensworth, Nagoaka, Keyes, Johnson & Beechum, 2012, p. 34**

Stinson (2008) calls for **new storytelling about academically and mathematically successful African American male students to counter negative messaging and provide positive role models**. Lee and Buxton (2010) recommend the following strategies for making learning opportunities more equitable: **value and respect the experiences and perspectives that all students bring to school from their backgrounds; articulate students’ cultural and linguistic knowledge with disciplinary knowledge; and offer sufficient and effective resources to support students**.

Social interaction about math is an important aspect of instruction at different levels of learning and in different contexts. A math-talk community has been shown to benefit English language learners in an urban setting (Hufferd-Ackles, Fuson, & Sherin, 2004). Similarly, when students in a transitional language classroom “communicate verbally and in writing about their mathematical ideas, they not only reflect on and clarify those ideas but also begin to become a community of learners” (Bray, Dixon, & Martinez, 2006, p. 138).

It is clear that academic belonging is not attained for all students via singular curricular materials or pedagogical methods or means of instructional support; **ensuring that all students, regardless of background characteristics, have the same likelihood of mathematical success requires a multi-faceted approach with high expectations, access to quality programs, and, at a core level, recognition of learners’ social and psychological attributes and contexts** (Gutiérrez, 2013; NCTM, 2014).

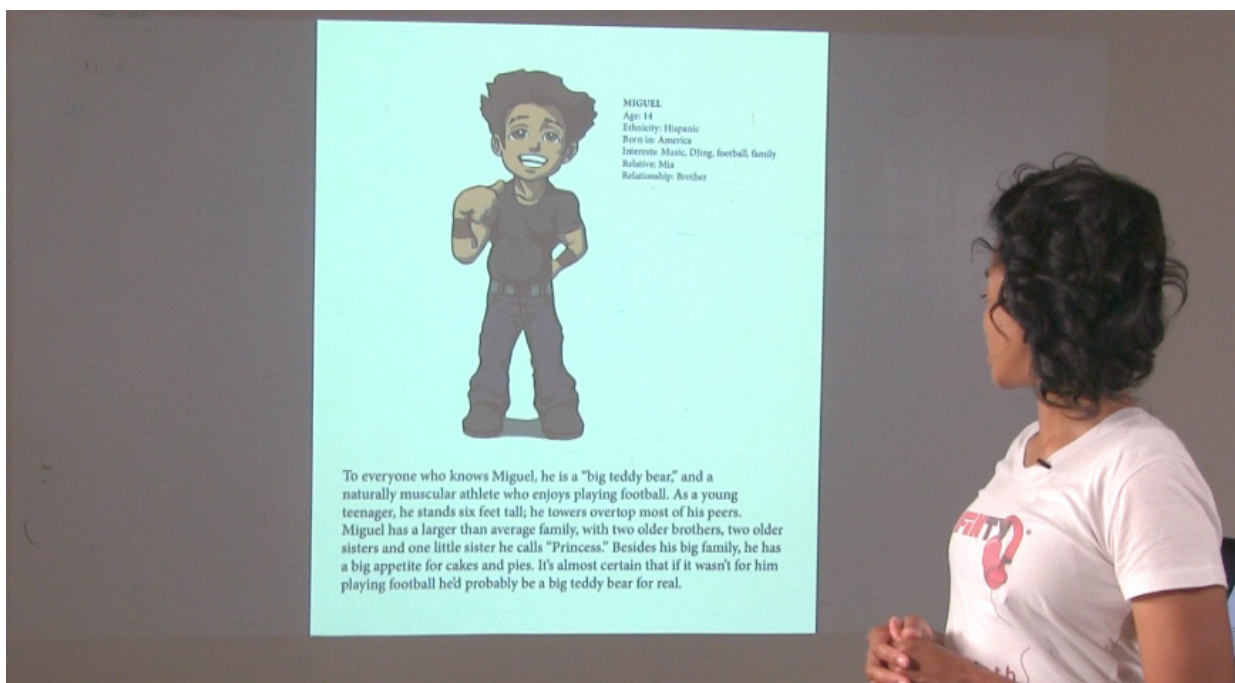


## How Lyrical Math supports social belonging for all students

An important feature of JFINTV Lyrical Math are stories of recurring characters representing diverse backgrounds with relatable backgrounds, challenges, and attributes. These characters overcome challenges and attain success—allowing students to envision themselves as similarly capable, with equal access to achievement in math.



To reinforce the belief that all students can be “good at math,” each lesson includes a detailed profile and biography of all the characters in the program. These profiles help students connect with the stories and see themselves as “lyrical mathematicians.”



Other engaging, relatable young people from diverse backgrounds are featured in the program's videos, providing more positive models for accessible, attainable educational success.



### *What the research says*

## **Students must be motivated to learn math—and motivation is increased through a variety of means**

Learning is an active process of engagement. If students are interested in what they are learning, they will persist in spending the time and energy needed for learning to occur (Eccles, Wigfield, & Schiefele, 1998; Guthrie & Humenick, 2004; Hidi & Boscolo, 2006). In this way, **engagement leads to motivation leads to learning**. As a result, effective teachers know that students must be engaged by the content to be motivated to persist; “Learning and succeeding in school requires active engagement” (Board on Children, Youth, and Families, 2003, p. 1).

Within the areas of science, technology, engineering and mathematics, **motivation and interest in subject matter are vital components of academic experiences that determines adolescents’ willingness to choose STEM-related career paths** (Kiemer, Groschner, Pehmer, Seidel 2014; National Research Council, 2011; Organization for Economic Cooperation and Development, 2007).

**“[F]ocus on the potential of students to develop their intellectual capacity provides a host of motivational benefits.”—Black, Trzesniewski, & Dweck, 2007, p. 260**

**Research suggests that integration of music in education within social contexts has positive motivating and rewarding effects** (Miendlarzeska & Trost, 2014).

### ***Goal-driven instruction***

Clearly identified expectations for learning and understanding in a mathematics classroom is essential for mathematical success (William, 2011). Clear goals foster motivation by encouraging student involvement in and responsibility for their own learning (Bransford, Brown, & Cocking, 2000). Clear goals within mathematics instruction provide teachers with opportunities to examine and monitor students’ progress and needs and then adjust instruction accordingly (Charles, 2005; Clements & Sarama, 2004; Sztajn, Confrey, Wilson, & Edgington, 2012).

### ***Meaningful and relevant experiences, real-world application***

Conceptual understanding is facilitated when learning is meaningful and connected to what students already know. When they are able to link procedures and concepts, retention improves and students are better able to apply what they know in different situations (Fuson, Kalchman, & Bransford, 2005). When students perceive concepts and tasks as interesting, relevant, and beneficial, motivation to learn increases (Czerniak, Weber, Sandmann, & Ahem, 1999). Real-world application is additionally motivating; students at all levels need to connect the mathematics they are learning to the world around them (Alberti, 2013).

### ***Communication and community***

Research indicates that the manner in which teachers interact with students and the type of social environment they create in their classrooms has significant influence on motivation (Fan & Williams, 2018; Schunk, Pintrich, & Meece, 2008).

### ***Technology use***

Effective technology use in the classroom, through web-based and multimedia learning, increases motivation as well as positive educational outcomes (Abdoolatiff & Narod, 2009; Chen, Lambert, & Guidry, 2010; Reinking, 2001; Tucker, 2012). This is likely because effective technology use promotes student agency and engagement (Schunk, Pintrich, & Meece, 2008).

## How Lyrical Math supports

Students' motivation to learn math—and succeed

*JFINTV Lyrical Math* makes use of a variety of motivating practices and features.

First and foremost, the program is FUN! Students are engaged with learning through hip-hop music and dance that gets them excited in learning. Compelling stories and characters and connections to peers featured in the videos further stimulate their interest. Mrs. Finney also provides a consistent, encouraging presence.





Each lesson identifies clear goals for teaching and learning. Students know from the beginning of each lesson what they are expected to learn and do. Lyrical Math also provides scripted guidance to aid teachers in getting students there. Clear targets make for purposeful learning.

The program's lyrics and narratives make the math concepts relevant to students, tapping into their experiences and interests while demonstrating the importance that math has in the world—and their own lives.



JFINTV offers school-wide programming to build excitement for math learning as well as a community of math learners. These assemblies connect, energize and inspire students and teachers.



"Students can feel math. Not only can they hear it, but they can also feel it."



Lyrical Math harnesses the power of technology to create an engaging multimedia edutainment experience for students.



# Lyrical Math

## Part 2

**I'M  
A  
LYRICAL  
MATHEMATICIAN**

Instagram @lyricalmath  
Facebook @JFINTV  
YouTube @lyricalmath  
Twitter @lyricalmath

[www.lyricalmath.com](http://www.lyricalmath.com)

1. HOME ROOM
2. KEEP IT MOVING  
DIVIDING WITH DECIMALS
3. LINE EM UP  
ADDING WITH DECIMALS
4. HOLD UP  
ADDING AND SUBTRACTING WITH FRACTIONS
5. SIMPLE AND PLANE  
COORDINATE PLANE
6. FILL IT UP  
VOLUME FORMULAS
7. HOW I ROCK  
CIRCUMFERENCE
8. GET AT ME  
AREA OF A CIRCLE
9. KEEP HUSTLING  
METRIC SYSTEM
10. WINNER  
TYPES OF ANGLES
11. THE WHY
12. DISMISSAL

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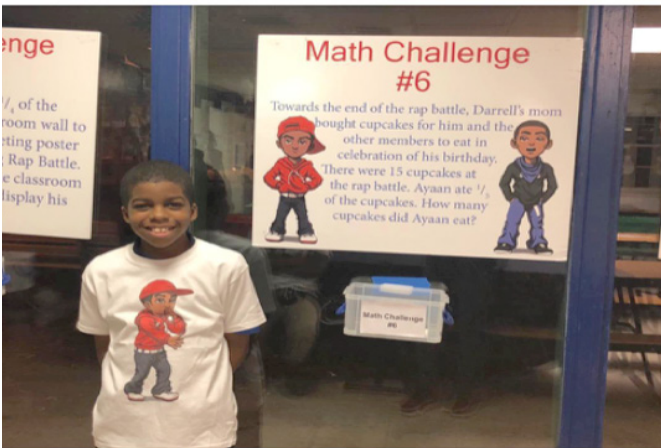




J FINTV Lyrical Math

December 18, 2018 · 🌐

Lyrical Math Performer with his favorite Lyrical Mathematician, Darrell and Ayaan! Lyrical Math Part 1 CDs, Lyrical Math Part 2 CDs, Lyrical Math 20-Week Program, Lyrical Math Live Performances, and more all available through [www.lyricalmath.com](http://www.lyricalmath.com) #lyrical-math #mathematics #mathematicians #mathteacher #mathtutor #mathisfun #math #scholars #hiphopeducation #hiphoped #musiceducation #lyricsoftheday #musicthatmatters #school #homeschool #homeschoolmom #music #rappers #rappersschool #femalemc #femalemcee #femalemc #blessed ##blackgirlsrock



J FINTV Lyrical Math

December 17, 2018 · 🌐

2018 Lyrical Mathematicians' Awards Ceremony!!! Beautiful Moments! Lyrical Math Part 1 CDs, Lyrical Math Part 2 CDs, Lyrical Math 20-Week Program, Lyrical Math Live Performances, and more all available through [www.lyricalmath.com](http://www.lyricalmath.com) #lyrical-math #mathematics #mathematicians #mathteacher #mathtutor #mathisfun #math #scholars #hiphopeducation #hiphoped #musiceducation #lyricsoftheday #musicthatmatters #school #homeschool #homeschoolmom #music #rappers #rappersschool #femalemc #femalemcee #femalemc #blessed ##blackgirlsrock



Lyrical Math makes motivation its mission. Beyond its core instructional content, the program features a wide variety of assets – from attire to social media platforms to award ceremonies – that reinforce positive messaging to promote confidence and celebrate achievements.





## WORKS CITED

- Abdoolatiff, S. & Narod, F. B. (2009). Investigating the effectiveness of computer simulations in the teaching of "atomic structure and bonding." *Chemistry Education in the ICT Age*, 85-100.
- Alibali, M. & Nathan, M. (2011). Embodiment in mathematics teaching and learning: Evidence from learners' and teachers' gestures. *Journal of the Learning Sciences*, 21(2), 247-286.
- An, S., Capararo, M. & Tillman, D. (2013). Elementary teachers integrate music activities into regular mathematics lessons: Effects on students' mathematical abilities. *Journal for Learning through the Arts*, 9(1), 1-19.
- Alberti, S. (2013). Making the shifts. *Educational Leadership*, December 2012/January 2013, 24-27.
- An, S. A., & Capraro, M. M. (2011). *Music-math Integrated Activities for Elementary and Middle School Students*. Irvine, CA: Education for All.
- An, S., Ma, T., & Capraro, M. M. (2011). Preservice teachers' beliefs and attitude about teaching and learning mathematics through music: An exploratory study. *School Science and Mathematics Journal*, 111, 235-247.
- An, S., & Tillman, D. (2015). Music activities as a meaningful context for teaching elementary students' mathematics: a quasi-experimental time series design with random assigned control group. *European Journal of Science and Mathematics Education*, 3(1), 45-60.
- Aronson, J., Fried, C. B., & Good, C. (2002). Reducing the effects of stereotype threat on African American college students by shaping theories of intelligence. *Journal of Experimental Social Psychology*, 38, 113-125.
- Ball, D., Ferrini-Mundy, J., Kilpatrick, J., Milgram, R. Schmid, W., & Schaar, R. (2005). *Reaching for Common Ground in K - 12 Mathematics Education*. Washington, DC: American Mathematical Society.
- Baker, A. & Cuevas, J. (2018). The importance of automaticity development in mathematics. *Georgia Educational Researcher*, 14(2), article 2.
- Bandura, A. (1986). *Social Foundations of Thought and Action: A Social Cognitive Theory*. Englewood Cliffs, NJ: Prentice Hall.
- Blackwell, L., Trzesniewski, K., & Dweck, C. S. (2007). Implicit theories of intelligence predict achievement across an adolescent transition: A longitudinal study and an intervention. *Child Development*, 78, 246-263.
- Boaler, J. (2011). Changing Students' Lives Through the De-tracking of Urban Mathematics Classrooms. *Journal of Urban Mathematics Education*, 4(1), 7-14.
- Boaler, J. (2016). *Mathematical Mindsets*. Hoboken, NJ: Wiley Press.

Board on Children, Youth, and Families. (2003). *Engaging schools: Fostering High School Students' Motivation to Learn*. Washington, DC: The National Academies Press. Retrieved online: <http://www.nap.edu/openbook.php?isbn=0309084350>.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (Eds.). (1999). *How People Learn: Brain, Mind, Experience, and School*. National Research Council. Washington, DC: National Academies Press.

Bray, W.S., Dixon, J.K., & Martinez, M. (2006). Fostering communication about measuring area in a transitional language class. *Teaching Children Mathematics*, 13(3), 132-138.

Burns, M. K., Ysseldyke, J., Nelson, P. M., & Kanive, R. (2014). Number of repetitions required to retain single-digit multiplication math facts for elementary students. *School Psychology Quarterly*, 30(3), 398-405.

Calvert, S. & Billingsley, R. (1998). Young children's recitation and comprehension of information presented by songs. *Journal of Applied Developmental Psychology*, 19(1), 97-108.

Charles, R.I. (2005). Big ideas and understandings as the foundation for elementary and middle school mathematics. *Journal of Mathematics Education Leadership*, 7(3), 9-24.

Chen, P., A. Lambert & K. Guidry. (2009). Engaging online learners: The impact of Web-based learning engagement on college student engagement. *Computers & Education*, 54, 1222-1232.

Cheryan, S., Plaut, V. C., Davies, P. G., & Steele, C. M. (2009). Ambient belonging: How stereotypical cues impact gender participation in computer science. *Journal of Personality and Social Psychology*, 97(6), 1045-1060.

Claussen D. W., Thaut M. H. (1997). Music as a mnemonic device for children with learning disabilities. *Canadian Journal of Music Therapy*, 5, 55-66.

Clements, D.H., & Sarama, J. (2004). Learning trajectories in mathematics education. *Mathematical Thinking and Learning*, 6(2), 81-89.

Council of Economic Advisors. (2015). *The economics of early childhood investments*. Washington, DC: Executive Office of the President.

Czerniak, C.M., Weber, W.B., Jr., Sandmann, A., & Ahem, J. (1999). A literature review of science and mathematics integration. *School Science & Mathematics*, 99(8), 421-430.

Dweck, C. (2006). *Mindset: The New Psychology of Success*. New York: Random House.

Dweck, C. (2008). *Mindsets and Math/Science Achievement*. New York, NY: Carnegie Corporation of New York Institute for Advanced Study.

Dweck, C.S. & Leggett, E.L. (1988). A social-cognitive approach to motivation and personality. *Psychological Review*, 95, 256-273.

Dweck, C.S., Walton, G.M., & Cohen, G.L. (2011) *Academic tenacity: Mindsets and skills that promote long-term learning*. White paper prepared for the Gates Foundation. Seattle, WA.

- Eccles, J.S., Wigfield, A., & Schiefele, U. (1998). Motivation to succeed. In *Handbook of Child Psychology: Volume 3 - Social, Emotional, and Personality Development* (5th ed.). N. Eisenberg (Ed.). New York, NY: Wiley Press.
- Fan, W. & Williams, C. (2018). The Mediating Role of Student Motivation in the Linking of Perceived School Climate and Achievement in Reading and Mathematics. *Frontiers in Education*. Retrieved online: <https://www.frontiersin.org/articles/10.3389/feduc.2018.00050/full>
- Farrington, C.A., Roderick, M., Allensworth, E., Nagaoka, J., Keyes, T.S., Johnson, D.W., & Beechum, N.O. (2012). Teaching adolescents to become learners. The role of noncognitive factors in shaping school performance: A critical literature review. Chicago, IL: University of Chicago Consortium on Chicago School Research.
- Flores-Gonzalez, N. (2002). *School Kids/Street Kids: Identity Development in Latino Students*. New York, NY: Teachers College Press.
- Franke, M. L., Kazemi, E., & Battey, D. S. (2007). Mathematics teaching and classroom practices. In F. K. Lester Jr. (Ed.), *The Second Handbook of Research on Mathematics Teaching and Learning* (pp. 225-256). Charlotte, NC: Information Age.
- Fuson, K.C., Kalchman, M., & Bransford, J.D. (2005). Mathematical understanding: An introduction. In M.S. Donovan & J.D. Bransford (Eds.), *How Students Learn: History, Math, and Science in the Classroom* (pp. 217-256). Washington, DC: National Academy Press.
- Gardner, H. (1993). *Multiple Intelligences*. New York: Basic Books.
- Gersten, R., Beckmann, S., Clarke, B., Foegen, A., Marsh, L., Star, J. R., & Witzel, B. (2009). *Assisting students struggling with mathematics: Response to Intervention (RtI) for elementary and middle schools* (NCEE 2009-4060). Washington, DC: National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education. Retrieved from <http://ies.ed.gov/ncee/wwc/publications/practiceguides/>.
- Glastra, F. J., Hake, B. J., & Schedler, P. E. (2004). Lifelong learning as transitional learning. *Adult Education Quarterly*, 54(4), 291-307.
- Good, C., Rattan, A. & Dweck, C. (2012). Why do women opt out? Sense of belonging and women's representation in mathematics. *Journal of Personality and Social Psychology*, 102(4), 700-717.
- Greene, G. (1999). Mnemonic multiplication fact instruction for students with learning disabilities. *Learning Disabilities Research & Practice*, 14(3), 141.
- Guthrie, J. T., & Humenick, N. M. (2004). Motivating students to read: Evidence for classroom practices that increase reading motivation and achievement. In *The Voice of Evidence in Reading Research*. P. McCardle, & V. Chhabra (Eds.). pp. 329-354. Baltimore, MD: Paul H Brookes Publishing.
- Gutiérrez, R. (2013). The sociopolitical turn in mathematics education. *Journal for Research in Mathematics Education*, 44(1), 37-68.

- Hanushek, E. A., & Wöessmann, L. (2007). Education quality and economic growth. Washington, DC: International Bank for Reconstruction and Development/The World Bank.
- Hidi, S., & P. Boscolo. (2006). Motivation and writing. In *Handbook of Writing Research*, C.A. MacArthur, S. Graham, & J. Fitzgerald (Eds.). 144-157. NY: The Guilford Press.
- Hiebert, J., & Grouws, D.A. (2007). The effects of classroom mathematics teaching on students' learning. Second handbook of research on the teaching and learning of mathematics. Reston, VA: National Council of Teachers of Mathematics. 371-404.
- Holmes, S. & Hallam, S. (2017). The impact of participation in music on learning mathematics. *London Review of Education*, 15(3), 425-438.
- Hufferd-Ackles, K., Fuson, K.C., & Sherin, M.G. (2004). Describing levels and components of a Math-Talk Learning Community. *Journal for Research in Mathematics Education*, 35(2), 81-116.
- Kiemer, K. Alexander Groschner, A., Pehmer, A. & Siedel, T. (2015). Effects of a classroom discourse intervention on teachers' practice and students' motivation to learn mathematics and science. *Learning and Instruction*, 35, 94-103.
- Larnell, G., Boston, D. & Bragelman, J. (2014). The stuff of stereotypes: Toward unpacking identity threats amid African American students' learning experiences. *The Journal of Education*, 194(1), 49-57.
- Lee, O. & Buxton, C. (2010). *Diversity and Equity in Science Education: Research, Policy, and Practice*. Multicultural Education Series. New York, NY: Teachers College Press.
- Leonard, A. & Bannister, N. (2018). Dancing our way to geometric transformations. *Teaching in the Middle School*, 23(5), 258-267.
- Loveless, T. (2011). The 2010 Brown Center report on American education: How well are American students learning? With sections on international tests, who's winning the real race to the top, and NAEP and the Common Core State Standards. Volume II, Number 5. Brown Center on Education Policy at Brookings.
- Manalo, E., Bunnell, J. & Stillman, J. (2000). The Use of Process Mnemonics in Teaching Students with Mathematics Learning Disabilities. *Learning Disability Quarterly*, 23(2), pp. 137-156.
- Martin, D. B., & Larnell, G. V. (2013). Urban mathematics education. In H. R. Milner & K. Lomotey (Eds.), *Handbook of Urban Education* (pp. 373-393). New York, NY: Routledge.
- McGee, D., Brewer, M., Hodgson, T., Richardson, P., Gonulates, R., & Weinel, R. (2018). A districtwide study of automaticity when included in concept- based elementary school mathematics instruction. *School Science & Mathematics*, 117(6), 259-268.
- Miendlarzewska, E. & Trost, W. (2014). How musical training affects cognitive development: rhythm, reward and other modulating variables. *Frontiers in Neuroscience*, 7(279). Retrieved online: <https://www.frontiersin.org/articles/10.3389/fnins.2013.00279/full>

- National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. Reston, VA: Author.
- National Council of Teachers of Mathematics. (2014). *Principles to actions: Ensuring mathematical success for all*. Reston, VA: Author.
- National Mathematics Advisory Panel. (2008). *Foundations of Success: The Final Report of the National Mathematics Advisory Panel*. Washington, DC: U.S. Department of Education.
- National Research Council. (1999). *How People Learn: Brain, Mind, Experience, and School*. Washington, DC: National Academy Press.
- National Research Council. (2001). *Adding it up: Helping children learn mathematics*. J. Kilpatrick, J. Swafford, & B. Findell (Eds.). Washington, DC: Mathematics Learning Study Committee, Center for Education, Division of Behavioral and Social Science and Education.
- National Research Council. (2005). *How Students learn: Mathematics in the Classroom*. Washington, DC: National Academies Press.  
Retrieved online: from <http://www.nap.edu/openbook.php?isbn=0309089492>
- National Research Council. (2011). *Successful K-12 STEM Education: Identifying Effective Approaches in Science, Technology, Engineering, and Mathematics*. Committee on Highly Successful Schools or Programs for K-12 STEM Education, Board on Science Education and Board on Testing and Assessment. Washington, DC: The National Academies Press.
- National Research Council and the Institute of Medicine. (2004). *Engaging schools: Fostering high school students' motivation to learn*. Washington, DC: National Academies Press.
- Nelson, P. M., Burns, M. K., Kanive, R. & Ysseldyke, J. E. (2013). Comparison of a math fact rehearsal and a mnemonic strategy approach for improving math fact fluency. *Journal of School Psychology, 51(6), 659- 667*. Retrieved from <http://www.sciencedirect.com.libproxy.ung.edu/science/article/pii/S0022440513000861>
- Organization for Economic Cooperation and Development. (2013). PISA 2012 assessment and analytical frame- work: Mathematics, reading, science, problem solving and financial literacy. Paris, France: Author.
- Osterman, K.F. (2000). Students' need for belonging in the school community. *Review of Educational Research, 70(3), 323-367*.
- Oyserman, D., Terry, K., & Bybee, D. (2002). A possible selves intervention to enhance school involvement. *Journal of Adolescence, 25, 313-326*.
- Parsons, M. (2004). Art and integrated curriculum. In E. Eisner and M. Day (Eds.), *Handbook of Research and Policy in Arts Education* (pp. 775-794). Mahwah, NJ: Lawrence Erlbaum.
- Pasquale, M. (2015). Productive struggle in mathematics. Interactive STEM Research Brief. Retrieved online: <http://interactivestem.org/wp-content/uploads/2015/08/EDC-RPC-Brief-Productive-Struggle.pdf>

Pegg, J., Graham, L., & Bellert, A. (2005). The effect of improved automaticity of basic number skills on persistently low-achieving pupils. In H. L. Chick & J. L. Vincent (Eds.), *Proceedings of the 29th conference of the international group for the psychology of mathematics education*, Vol. 4 (pp. 49-56). Melbourne: PME.

Peterson, D. & Thaut, M. (2007). Music increases frontal EEG coherence during verbal learning. *Neuroscience Letters*, 417, 217-221.

Pew Research Center. (2017). U.S. students' academic achievement still lags that of their peers in many other countries. FactTank: News in the Numbers. Retrieved online: <https://www.pewresearch.org/fact-tank/2017/02/15/u-s-students-internationally-math-science/>.

Rattan, A., Good, C., & Dweck, C. (2011). "It's ok – Not everyone can be good at math": Instructors with an entity theory comfort (and demotivate) students. *Journal of Experimental Social Psychology*, 48, 731-737.

Rattan, A. Savani, K., Chugh, D. & Dweck, C. (2015). Leveraging mindsets to promote academic achievement: Policy recommendations. *Perspectives on Psychological Science*, 10(6), 721-726.

Rauscher, F. & Hinton, S. (2011). Music instruction and its diverse extra-musical benefits. *Music Perception: An Interdisciplinary Journal*, 29(2), 215-226.

Rauscher, F., Shaw, G., Levine, L., Ky, K. & Wright, E. (1994). Music and Spatial Task Performance Causal Relationship. Paper presented at the Annual Meeting of the American Psychological Association (102nd, Los Angeles, CA, August 12-16, 1994).

Rauscher, F. H., Shaw, G. L., Levine, L. J., Wright, E. L., Dennis, W. R., & Newcomb, R. L. (1997). Music training causes long-term enhancement of preschool children's spatial-temporal reasoning. *Neurological Research*, 19(1), 2-8.

Reinking, D. (2001). Multimedia and engaged reading in a digital world. In *Literacy and motivation: Reading engagement in individuals and groups*, L. Verhoeven & C. Snow (Eds.). 195-221. Mahwah, NJ: Lawrence Erlbaum Associates.

Riley, N., Lubans, D. R., Holmes, K., Hansen, V., Gore, J., & Morgan, P. J. (2017). Movement-based mathematics: enjoyment and engagement without compromising learning through the EASY Minds program. *Eurasia Journal of Mathematics, Science and Technology Education*, 13(6), 1653-1673.

Rittle-Johnson, B., Siegler, R.S., & Alibali, M.W. (2001). Developing conceptual and procedural skill in mathematics: An iterative process. *Journal of Educational Psychology*, 93(2), 346-362.

Robertson, W., & Lesser, L. M. (2013). Scientific skateboarding and mathematical music: Edutainment that actively engages middle school students. *European Journal of Science and Mathematics Education*, 1(2), 60-68.

Schellenberg, E. G. (2004). Music lessons enhances IQ. *Psychological Science*, 15(8), 511-514.

Shapiro, J. & Williams, A. (2011). The role of stereotype threats in undermining girls' and women's performance and interest in STEM. *Sex Roles*, 66, 175-183.



Simmons-Stern, R., Budson, A. & Ally, A. (2010). Music as a memory enhancer in patients with Alzheimer's Disease. *Neuropsychologia*, 48(10), 3164-3167.

Spelke, E. S. (2008). *Learning, Arts and the Brain: The Dana Consortium Report on Arts and Cognition*. NY/Washington D.C.: Dana Press.

Steele, C.M., and Aronson, J. (1995). Stereotype threat and the intellectual test performance of African Americans. *Journal of Personality and Social Psychology*, 69(5), 797-811.

Stephens, N. M., Hamedani, M. G., & Destin, M. (2014). Closing the social-class achievement gap: A difference education intervention improves first-generation students' academic performance and all students' college transition. *Psychological Science*, 25, 943-953.

Stickney, E. M., Sharp, L. B., & Kenyon, A. S. (2012). Technology-enhanced assessment of math fact automaticity: Patterns of performance for low- and typically achieving students. *Assessment for Effective Intervention*, 37(2), 84-94.

Stinson, D. (2008). Negotiating sociocultural discourses: The counter-storytelling of academically (and mathematically) successful African American male students. *American Educational Research Journal*, 45(4), 975-1010.

Sztajn, P., Confrey, J., Wilson, P.H., & Edgington, C. (2012). Learning trajectory based instruction: Towards a theory of teaching. *Educational Researcher*, 41(5), 147-156.

Tucker, B. (2012). The flipped classroom. *Education Next*, 12(1), 82-83.

U.S. Department of Education Institute of Education Sciences (2017). National Center for Education Statistics, National Department of Education Progress (NAEP). Mathematics assessment. Retrieved online: <https://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2018037>

Usher, E. L., & Pajares, F. (2008). Sources of self-efficacy in school: Critical review of the literature and future directions. *Review of Educational Research*, 78(4), 751-796.

Walton, G. & Cohen, G. (2007). A question of belonging: Race, social fit, and achievement. *Journal of Personality and Social Psychology*, 92, 82-96.

Walton, G. & Cohen, G. (2011). A brief social-belonging intervention improves academic and health outcomes of minority students. *Science*, 331. 1447-1451.

Walton, G. & Spencer, S. (2009). Latent ability: Grades and test scores systematically underestimate the intellectual ability of negatively stereotyped students. *Psychological Science*, 20(9), 1132-1139.

William, D. (2011). *Embedded Formative Assessment*. Bloomington, IN: Solution Tree Press.

Woodward, J. (2006). Developing automaticity in multiplication facts: Integrating strategy instruction with timed practice drills. *Learning Disability Quarterly*, 29(4), 269-289.

Yeager, D. & Dweck, C. (2012). Mindsets that promote resilience: When students believe that personal characteristics can be developed. *Educational Psychologist*, 47(4), 302-314.

Yeager, D., Walton, G. & Cohen, G. (2013). Addressing achievement gaps with psychological interventions. *Kappan*, 94(5), 63-65.