Factors Affecting Eighth-Grade Math Proficiency

The National Council of Teachers of Mathematics (NCTM) provides six principles for school mathematics: equity, curriculum, teaching, technology, learning, and assessment. These principles are listed with the practice and research implications that Learn4Life has identified by analyzing our metro-Atlanta 8th grade math proficiency data.

Factor	Definition
Access to Rigorous Courses	Students need access to rigorous math courses throughout middle school, including algebra in 8th grade.
Gender Expectations	Teachers' and parents' expectations for boys' and girls' math performance affects outcomes.
Racial Expectations	Attending a racially segregated school lowers achievement levels for minority students.
School Culture	A school's culture—safety, discipline policies, expectations, etc.—affects math test outcomes.
Relevant Curriculum	Application-based, integrated math curriculum raises proficiency levels.
Interventions for Struggling Learners	Students with missing basic skills such as number sense, or cognitive skills, such as working memory, require early and intensive math interventions in order to be successful on grade-level tests.
Teacher Effectiveness	Teacher effectiveness—including teacher content knowledge, teaching conceptually rather than just procedurally, and instructional strategies—significantly impacts student outcomes.
Academic Preparation	Math skills build upon prior learned skills. Concepts tested in eighth grade have foundations in earlier grades, such that success is dependent upon a chain of teachers and curricula.

Access to Appropriate Technology	When implemented according to research, technology such as supplemental online learning programs can raise student math achievement.
Math Anxiety	Students' self-conceptions, as co-constructed with teachers and parents, about their ability to learn math affects their achievement.
Literacy and Language Skills	Students' literacy levels and English-language learner status affects their ability to score well on math exams.
Use of Assessment Data	Formative assessments that are aligned to year-end tests provide data that should inform instructional adjustments in order to increase proficiency.

Factor	Additional Details and Research
Equity: Access to Rigorous Courses	"Accelerated math placement of relatively low- skilled middle schoolers increases the fraction of later enrolling in Precalculus by one-seventh, and by over one-third for female and non-low income students. Acceleration increases college readiness and intentions to pursue a bachelor's degree." Dougherty, S. M., Goodman, J. S., Hill, D. V., Litke, E. G., & Page, L. C. (2017). Objective course placement and college readiness: Evidence from targeted middle school math acceleration. *Economics Of Education Review*, *58*141-161. doi:10.1016/j.econedurev.2017.04.002
Equity: Gender Expectations	"Despite an overrating of girls on the surface, teachers rate the math proficiency of girls lower than that of similarly performing and behaving boys, and this underrating of girls likely contributes to the early development of the gender gap in math." Robinson-Cimpian, J. P., Theule Lubienski, S., Ganley, C. M., & Copur-Gencturk, Y. (2014). Are Schools Shortchanging Boys or Girls? The Answer Rests on Methods and Assumptions: Reply to Card (2014) and Penner (2014). *Developmental Psychology*, *50*(6), 1840-1844. doi:10.1037/a0036693
Equity: Racial Expectations	"Being in a school with a high a concentration of Black and Hispanic students lessens all students' chances of academic achievement, even for students who otherwise should excel." Brown-Jeffy, S. (2009). School Effects: Examining the Race Gap in Mathematics Achievement. *Journal Of African American Studies*, *13*(4), 388-405. doi:10.1007/s12111-008-9056-3
Equity: School Culture	"The relationship between school culture and academic achievement was tested through meta-analysis…and it was confirmed that school culture had a statistically significant effect on students' academic achievement." Bektas, F., Karadag, E., Ay, Y., & Cogaltay, N. (2015). School Culture and Academic Achievement of Students: A Meta-analysis Study. *Anthropologist*, *21*(3), 482-488.

Curriculum: Relevant Curriculum	"Results of this study support the hypothesis that mathematics-infused science at the eighth-grade level significantly impacts student mathematics content knowledge. When compared with students who did not experience the intervention, students in the infusion group showed statistically significant increases on the overall mathematical content assessment, as well as in subcategories of the assessment divided by area of cognitive domain complexity and difficulty of mathematics. Most notably, student reasoning skills increased for those in the infusion group above and beyond what would be expected during a typical school year." Burghardt, M. D., Lauckhardt, J., Kennedy, M., Hecht, D., & McHugh, L. (2015). The Effects of a Mathematics Infusion Curriculum on Middle School Student Mathematics Achievement. *School Science & Mathematics*, *115*(5), 204-215. doi:10.1111/ssm.12123 "We find that the reported use of computers, calculators or other machines in the classroom (representing technology integration, a commonly advocated STEM learning principle) correlates with gains in both math and science similar in magnitude to the strong positive gains associated with the reported practice of listening and taking notes in class… Overall, survey items capturing a dimension of these STEM learning principles generally show statistically significant, positive associations with student gains in math and sciences." Hansen, M., & Gonzalez, T. (2014). Investigating the Relationship between STEM Learning Principles and Student Achievement in Math and Science. *American Journal Of Education*, *120*(2), 139-171.
Teaching: Interventions for Struggling Learners	"The effects of a mathematical problem-solving intervention on students' problem-solving performance and math achievement were measured in a randomized control trial with 1,059 7th-grade students…Problem-solving performance was assessed using curriculum-based math problem-solving measures, which were administered as a pretest and then monthly over the course of the 8-month intervention. Students who received the intervention (*n* =

	644) embedded in the district curriculum showed a significantly greater rate of growth on the curriculum-based measures than students in the comparison group (*n* = 415) who received the district curriculum only." Montague, M., Krawec, J., Enders, C., & Dietz, S. (2014). The effects of cognitive strategy instruction on math problem solving of middle-school students of varying ability. *Journal Of Educational Psychology*, *106*(2), 469-481. doi:10.1037/a0035176 "Self-regulation skills have been found to be an important predictor of achievement in mathematics. Teaching a student to regulate his or her behavior during independent math work sessions using self-monitoring of performance with self-graphing focuses him or her on academic performance and results in increases in productivity and math proficiency." Wells, J. C., Sheehey, P. H., & Sheehey, M. (2017). Using Self-Monitoring of Performance With Self-Graphing to Increase Academic Productivity in Math. *Beyond Behavior*, *26*(2), 57. doi:10.1177/1074295617711207
Teaching: Teacher Effectiveness	"Conceptual math generally seeks to cultivate students' overall understanding of different math concepts, and lessen their reliance on memorizing set formulas and procedures. This article examines the math proficiency increases in San Diego and Boston, which administrators attribute to teaching conceptually." Cavanagh, S. (2006). Big Cities Credit Conceptual Math For Higher Scores. *Education Week*, *25*(18), 1-15. "Districts and schools may benefit from investing their professional development funds and resources in facilitating teacher-centered collaborative and research-based learning activities in order to improve student learning." Akiba, M., & Liang, G. (2016). Effects of teacher professional learning activities on student achievement growth. *Journal Of Educational Research*, *109*(1), 99-110. doi:10.1080/00220671.2014.924470

	"Data were also collected on students' gender, ethnicity, special education classification, and English as a Second Language enrollment, as well as on school, grade, and teacher identifiers. The study estimated teacher fixed effects while controlling for fixed student characteristics and classroom specific variables. Data analysis indicated that there were large and statistically significant differences among teachers. A one standard deviation increase in teacher quality raised students' reading and math test scores by approximately .20 and .24 standard deviations, respectively, on a nationally standardized scale." Rockoff, J. E. (2004). The impact of individual teachers on student achievement: Evidence from panel data, 247–252. doi:10.1257/0002828041302244
Teaching: Academic Preparation	"Learning is supported by activating a conceptually relevant prior-knowledge analogue." Sidney, P. G., & Alibali, M. W. (2015). Making Connections in Math: Activating a Prior Knowledge Analogue Matters for Learning. *Journal Of Cognition & Development*, *16*(1), 160-185. doi:10.1080/15248372.2013.792091 "Children with little prior knowledge of correct solution strategies benefited from feedback during exploration, but children with some prior knowledge of a correct solution strategy benefited more from exploring without feedback. These results suggest that theories of learning need to incorporate the role of prior knowledge and that providing feedback may not always be optimal." Fyfe, E. R., Rittle-Johnson, B., & DeCaro, M. S. (2012). The effects of feedback during exploratory mathematics problem solving: Prior knowledge matters. *Journal Of Educational Psychology*, *104*(4), 1094-1108. doi:10.1037/a0028389
Technology: Access to Appropriate Technology	"Results showed that the students taught with [blended learning/online math program] outscored their [control group] counterparts on three of four math measures… Helping students develop a sound conceptual understanding of fractions, not simply

	procedural, was especially important." Bottge, B. A., Ma, X., Gassaway, L., Toland, M. D., Butler, M., & Cho, S. (2014). Effects of Blended Instructional Models on Math Performance. *Exceptional Children*, *80*(4), 423-437. doi:10.1177/0014402914527240 "Our findings indicate that it is more critical to examine dosage or frequency of implementing the curriculum, irrespective of whether teachers adhered to the design, in order to understand outcomes." Karam, R., Pane, J., Griffin, B., Robyn, A., Phillips, A., & Daugherty, L. (2017). Examining the implementation of technology-based blended algebra I curriculum at scale. *Educational Technology Research & Development*, *65*(2), 399-425. doi:10.1007/s11423-016-9498-6
Learning: Math Anxiety	"High- and low-anxiety teachers may design their lessons differently, spend different amounts of time on math, differentially spark student interest in math, and/or respond differently to students' questions and errors. Additionally, math-anxious teachers and parents may engage in more direct transmission of negative or fearful attitudes via negative comments about math or their own math ability." Foley, A. E., Herts, J. B., Borgonovi, F., Guerriero, S., Levine, S. C., & Beilock, S. L. (2017). The Math Anxiety-Performance Link: A Global Phenomenon. *Current Directions In Psychological Science*, *26*(1), 52-58. doi:10.1177/0963721416672463
Learning: Literacy and Language Skills	The purpose of this paper is to examine the magnitude and determinants of the relation between arithmetic and reading performance during elementary and middle school years. We meta-analyzed 210 correlations between math and reading measures, coming from 68 independent samples (the overall sample size was 58923 participants). The meta-analysis yielded an average correlation of 0.55 between math and reading measures." Singer, V., & Strasser, K. (2017). The association between

	arithmetic and reading performance in school: A meta-analytic study. *School Psychology Quarterly*, *32*(4), 435-448. doi:10.1037/spq0000197 "Analysis reveals English proficiency as a statistically significant predictor of mathematics scores. Mathematics scores increase simultaneously with English proficiency but inversely with grade level. Grade level moderates the influence of English proficiency on mathematics scores." Henry, D. L., Nistor, N., & Baltes, B. (2016). Examining the Relationship between Math Scores and English Language Proficiency. *Journal Of Educational Research And Practice*, *4*(1), 11-29.
Assessments: Meaningful Use of Assessment Data	"Formative assessment is an evidence-based process of gathering information on three questions: (a) Where am I going? (b) How am I doing now? (c) Where do I go next? to support a learning cycle (Hattie & Timperley, 2007; Sadler, 1989). Therefore, the most important formative assessment practices involve (a) students' understanding of their learning goals and targets, (b) the criteria by which they will know how they are progressing with their learning, and (c) what needs to be done next to move learning forward. Feedback is an active part of the process and can address the task, the student's processing of the task, suggestions for what to work on next, and scaffolds for the individual student." Beesley, A. D., Clark, T. F., Dempsey, K., & Tweed, A. (2018). Enhancing Formative Assessment Practice and Encouraging Middle School Mathematics Engagement and Persistence. *School Science & Mathematics*, *118*(1/2), 4-16. doi:10.1111/ssm.12255