# The Benefits of Hands-on, Relevant Learning Experiences in Mathematics: Supporting English Learners

Overview of GA Mathematics Resources:

- The Georgia DOE Office of Mathematics has a wide variety of resources to support students, teachers, and leaders throughout the state. These resources offer the tools and support resources needed to meet the individualized learning needs of all students. These resources include standards, curriculum maps, comprehensive grade level/course curriculum overviews, instructional unit frameworks, parent letters, videos, support materials, and intervention resources. All of these resources provide strategies for teaching and learning that can be used to support all learners, including English Learners (ELs). These resources can be found on GSO using the following link: (https://www.georgiastandards.org/Georgia-Standards/Pages/Math.aspx) and in the Teacher Resource Link within the state-wide Student Longitudinal Data System (SLDS).
- The Georgia Instructional Practices Guide for Mathematics provides instructional strategies that accommodate the individual learning needs of each learner, including English Learners. This resource can be found here: https://www.georgiastandards.org/Georgia-Standards/Documents/GSE-Effective-Instructional-Practices-Guide.pdf

Evidence-Based Instructional Strategies:

- **Using Visuals and Concrete Representations of Mathematics**
  - Especially for language learners, visual representations of the mathematics are important. Visual representations and visual models used instructionally reduce the language demand to assist with the accessibility of the mathematics content. This is an important skill because higher-level mathematics and science courses increasingly draw on visualization and spatial reasoning skills to solve problems (Zhang, Ding, Stegall, & Mo, 2012). Using visuals is an important strategy to help learners, especially English Learners as they learn to investigate the best way to answer a problem in mathematics. In a ground-breaking study, Joonkoo Park & Elizabeth Brannon (2013) found that the most powerful learning occurs when learners use different areas of the brain. When students work with symbols, such as numbers, they are using a different area of the brain than when they work with visual and spatial information, such as an array of dots. The researchers found that mathematics learning and performance was optimized when the two areas of

the brain were communicating (Park & Brannon, 2013). Additionally, the researchers found that training students through visual representations improved students' mathematics performance significantly. This is also applicable to English Learners because the visual representation of the mathematics being presented would lead to improved mathematics performance with this group of learners.
    - https://www.youcubed.org/resources/visual-math-improves-math-performance/
    - https://bhi61nm2cr3mkdgk1dtaov18-wpengine.netdna-ssl.com/wp-content/uploads/2017/03/Visual-Math-Paper-vF.pdf
    - Making mathematics more concrete, accessible and comprehensible assists English Learners with their development of a solid comprehension of the mathematics.
    - Researchers suggest that teachers of English Learners identify and use instructional strategies that make content more accessible (Kersaint, Thompson, & Petkova, 2013), and consider how to implement culturally relevant pedagogy in mathematics classrooms (Aguirre & Zavala, 2013; Gay, 2000).
    - Reducing the language demand and complexity without reducing the rigor of the mathematics is an effective instructional strategy that allows all learners, including English Learners, to access the mathematics and develop the mathematical thinking necessary to build a solid understanding (i.e., 3-act tasks, visual patterns, visual models, concrete manipulatives).
    - https://files.eric.ed.gov/fulltext/ED534228.pdf

- **Rigorous, relevant, hands-on learning experiences (i.e., STEM/STEAM)**
    - Classroom environments that promote active engagement as students learn mathematics allow learners to deepen their mathematics understanding.
    - Evidence-based research has shown that when teaching mathematics learners, it is important for teachers to establish learning environments and classroom norms that support the active engagement of all students, including ELs. In these type of learning environments, the teacher honors the diverse ways in which students approach mathematics, communicate their mathematical thinking (Moschkovich, 2009), and record their strategies and solutions to problem-solving tasks (Tankersley, 1993). http://www.ascd.org/publications/educational-leadership/may93/vol50/num08/Teaching-Math-Their-Way.aspx
    - When classroom teachers encourage mathematics classroom discussions in ways that support acquisition of mathematics concepts and language development, student learning increases (Smith & Stein, 2011). It is important for all students, but especially critical for ELs, to have opportunities to speak, write, read, and listen in mathematics classes, with teachers providing appropriate linguistic support and encouragement.

## Incorporating the 8 Standards for Mathematical Practice into Daily Lessons

*"The Standards for Mathematical Practice describe ways in which developing student practitioners of the discipline of mathematics increasingly ought to engage with the subject matter as they grow in mathematical maturity and expertise throughout the elementary, middle and high school years."*

*~Georgia Standards of Excellence for Mathematics*

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

More details on the 8 Standards for Mathematical Practice can be found in the specific grade-level/course curriculum overviews at https://www.georgiastandards.org/Georgia-Standards/Pages/Math.aspx

Additional Strategies and Supports for ELs in Math
(Source: Academic Language in Diverse Classrooms: Promoting Content and Language Learning, Gottlieb, Margo & Ernst-Slavit, Gisela, 2013.)

- **Using Realia, Pictures, and Visuals to Build Background Knowledge and Practice Concepts**
  - Connecting to the senses of sight, touch, and sound, with realia, pictures or visuals (e.g., in print or on the Internet) helps students to build background knowledge as well as to understand and practice a unit's concepts.

- **Manipulatives**
  - Manipulatives help students respond to multiple types of mathematical activities. This works particularly well with students in all ELP levels who can demonstrate their learning visually and kinesthetically.

- **Pairs, Triads, and Small Groups**
  - Providing students with opportunities to practice both the academic language of mathematics and mathematics content information as they strategize to solve real-world and mathematical problems is a valuable oral language practice for all students. Creating opportunities for students to work in small groups promotes academic language growth as well as practice in social skills (e.g., turn taking, questioning, praising). As they communicate with other students and critique the reasoning of their peers, their academic language and strategic reasoning abilities improve.

- **Interactive Writing Organizers**
  - Graphic organizers, used by pairs or triads of students to respond to mathematics problem-solving prompts, provide students with both oral brainstorming opportunities and opportunities to write academic dialogues. By adapting Jeff Zwiers' (2011) dialogue comic strip, for example, teachers can provide students with a way to model their learning through all four language modalities. Students create a dialogue in the bubbles to represent their conversation and solutions to problems. Then, they orally present their dialogues to their class.

- **Displaying Mathematics Word/Phrase Walls**
  - Knowledge of the mathematics register is an essential component of learning mathematics. In order to communicate mathematical thinking and understanding, students need to learn and use appropriate academic mathematics vocabulary and phrases. Mathematics word/phrase walls provide scaffolds to bridge general math language, such as 'goes into' and 'take away', with the technical terminology of mathematics, as in 'division' and 'subtraction'. Words and phrases are added as they are introduced in the day's lesson, and students can use appropriate words and terminology as needed.

- **Encouraging Student Interaction and Productive Classroom Discourse**
  - *Small groups:* During small group instruction, students work cooperatively to discuss the topic at hand, share information, explore and problem solve, or accomplish a common goal. This type of arrangement, coupled with well-designed content and language targets, provides opportunities for divergent thinking and encourages students to practice the specific content-area language.
  - *Think-Pair-Share*: This interactive cooperative strategy affords students time to formulate individual ideas and share these with another student. It encourages and honors student thinking about the concepts and ideas being discussed. It also promotes language use between peers and classroom participation by all students.
  - *Do-Talk-Record*: In this teaching strategy, learners engage in activities and thoroughly discuss them before recording any results. In this way, students have opportunities to communicate their strategic reasoning and practice the language of mathematics before they produce their answers. Teachers may focus on capturing students thinking to model the appropriate recording before students are asked to record their work independently in individual mathematics journals or notebooks.

- **Infusing Peer Assessment and Student Self-Assessment**
  - Peer assessment and self-assessment support student learning. These forms of assessment help clarify learning goals for students. If students identify an error and correct it, the learning is much greater than when the teacher gives this corrective feedback. In addition, by evaluating other students' work, students become aware of the different ways in which they might write a mathematical rule or expression. Finally, peer feedback is a good community builder in the classroom.

Supporting articles and research:

Aguirre, J. M., & Zavala, M. del R. (2013). Making culturally responsive mathematics teaching explicit: A lesson analysis tool. *Pedagogies: An International Journal*, 8(2), 163–190.

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Kersaint, G., Thompson, D. R., Petkova, M. (2013). Teaching mathematics to English language learners (2nd ed). New York, NY: Routledge.

Moschkovich, J. N. (2009). Using two languages when learning mathematics: How can research help us understand mathematics learners who use two languages (Research Brief). Retrieved from http://www.nctm.org/news/content.aspx?id=22838.

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National Council of Teachers of Mathematics. (2013). *Teaching Mathematics to English Language Learners*. NCTM. October 2013. Retrieved on 13 May 2018 from https://www.nctm.org/Standards-and-Positions/Position-Statements/Teaching-Mathematics-to-English-Language-Learners/.

Park, Joonkoo & Elizabeth M. Brannon. Improving arithmetic performance with number sense training: An investigation of underlying mechanism. *Cognition*. October 2014, Vol. 133, Issue 1, Pages 188-200.

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TODOS: Mathematics for All. (2007). Bibliography of Diversity and Equity in Mathematics Education. Retrieved on 13 May 2018 from http://www.todos-math.org/assets/documents/Bibliography/todosbibliography2007.pdf.

Zhang, Ding, Stegall, & Mo. (2012). The Effect of Visual-Chunking-Representation Accommodation on Geometry Testing for Students with Math Disabilities. *Learning Disabilities Research and Practice*. November 2012, Vol. 27, Issue 4. Pages 167-177.

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