Preparing English Learners to Access Rigorous, Grade-Level Math Content

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Introduction

Ellevation Education has been a leader in English Learner education since 2011. Over the past 9 years, Ellevation has had the opportunity to serve over 800 partner districts, over 200,000 educators and over 3 million current and former ELs across the U.S. Our products, a data and instructional planning platform, a teacher capacity-building solution, and a student math learning application, were built by a team of administrators, teachers, and technology experts with input from top language acquisition and math experts.

Ellevation Education is dedicated to helping ELs achieve their highest aspirations. We are inspired every day by the extraordinary contributions EL students make in school and society, often in the face of significant obstacles. All multilingual students bring important assets to their learning experiences. Learning a second language puts these students at an advantage for more quickly developing executive function skills in other contexts. This is called the "bilingual advantage" in some literature. This theory is built on the premise that multilingual students develop cognitive flexibility as they flexibly shift language for audience, context, and purpose. In an interconnected world, there is greater reliance on communication across cultures and therefore, an increased value placed on multilingualism in order to accomplish goals, especially in STEM fields.

The Challenge: Access to Rigor

Consistent with evolving state standards and curricula, math instruction and standardized tests have moved away from memorization and computation-based content in favor of a language-centric approach focusing on real-world application and word problems, both of which require academic English math vocabulary and critical reading skills that ELs are still developing. ELs experience an opportunity gap in the classroom, with English language proficiency frequently holding them back from participating in the authentic mathematics discussions that are essential to negotiating meaning and developing conceptual understanding. At its core, this challenge is about equity.

The persistent math opportunity gap for English Learners has long term consequences.

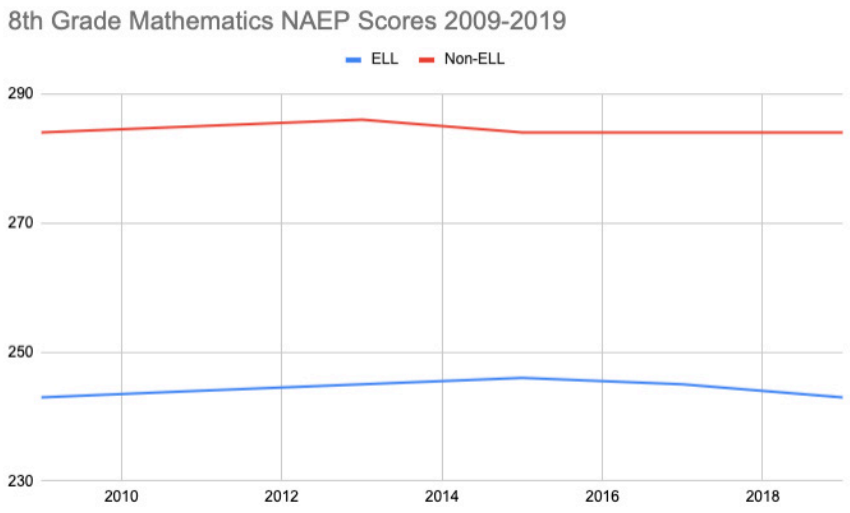
Without a strong command of the academic language of math, ELs will fail to gain the necessary knowledge and skills to advance. Studies show that early math performance is a key predictor of later academic success, and better performance in math is linked with opportunities for accelerated learning, such as gifted and talented classes. Today, ELs are underrepresented in gifted and talented programs in 49 states and the District of Columbia and see fewer opportunities for rigorous intellectual engagement (Sparks & Harwin, 2017).

To ensure opportunities for advancement, ELs in secondary grades must successfully acquire and use the academic vocabulary demanded by rigorous, grade-level content. Given the continued growth of ELs in our school systems, there is an urgent need to make rigorous math content more accessible. This challenge is not just about scores; it's about providing our ELs with the foundation to excel.

Mathematics: It's About Language

Given heavy language demands in math, it's unsurprising that English Learners are performing far below their Native English Speaking peers. According to the 2019 National Assessment of Educational Progress, 5% of 8th grade ELs scored at or above the proficient level in math, compared to 36% of non-English learners (NAEP Mathematics: National Achievement-Level Results, 2018). This gap in math performance has persisted for over a decade.

ELs require targeted strategies to achieve this universal goal of rigorous engagement with mathematical ideas and processes. A student who is still developing English language skills may be hesitant to speak up in a classroom setting, therefore missing a key learning opportunity. In order to engage more frequently and effectively in the social construction of knowledge, ELs first need low-stakes opportunities to develop their productive language.



The Center for Instruction, in a study for the U.S. DOE, noted that language is unattended to in the mathematics classroom. They state clearly that "the oral and written language of mathematics—or the mathematics register—should be expanded and explicitly integrated into the curriculum" (Francis et al., 2006). Projections show that by 2025, nearly 1 out of every 4 public school students will be an English Learner. This trend underscores the fact that there is an urgent need to make rigorous math content more accessible for this important and large segment of our student population.

As a product, Ellevation Math has a unique focus on secondary ELs, many of whom are Long Term ELs (LTELs). LTELs are students who have been in an EL program for over 5 years, and they represent about 60% of all secondary ELs (~1.2MM students). Despite being socially conversant in English, LTELs are persistently unable to pass the assessments necessary for exiting the EL program (Olson, 2014). The policy report "Reparable Harm" (Olsen, 2010) drew attention to the challenge, precipitating a shift in funding and focus for ELs in California. One of the key recommendations urged that "materials, language arts and math curriculum, and professional development must support the specific language and academic diagnosed needs of Long Term English Learners."

ELs have double the work when compared with their monolingual peers.

They must learn the rigorous concepts necessary for math achievement while also learning a new language.

(Short & Fitzimmons 2007).

The Ellevation Math Logic Model

Researchers cite academic language as the single most important factor impacting ELs (Francis et al., 2006). In general, the mathematics abilities that ELs bring to the classroom are on par with their monolingual peers. Yet, as noted earlier, an opportunity gap persists. Ellevation has formulated an asset-based theory of action that supports the impact Ellevation Math will have in both language and content gains. There are several research-based tenets for this theory of action:

A. Language is essential for content learning in mathematics, as in other subject areas, because it enables **rich discourse** that drives conceptual understanding.

B. Language learning must include direct instruction of **academic vocabulary**.

C. Learners better understand and apply language when it is built in a rich, meaningful **context**.

D. ELs benefit from access to **grade-level** concepts and rigor.

E. While rigorous, the content must be made **accessible** for ELs at all language proficiency levels. This can be done through the use of comprehensible input strategies.

F. To ensure language growth trajectories remain high for the full range of ELs, the learning experience must be **differentiated** by language proficiency.

Mathematics achievement is the ultimate goal of Ellevation Math. Ellevation Math promotes real world problem-solving skills and boosts student engagement with math learning.

Problem	ELs need academic language to access rigorous grade-level math content. Yet no current math, vocablary, or language programs address this specific need.
Research	Language is essential for learning math content. Language growth requires vocabulary instruction, meaingful context, comprehensible input, grade-level rigor, and differentiation.
Activities	EL students complete standards-aligned Primers before math instruction. Primers front-load key academic vocabulary in the context of a math problem and provide modeled think-alouds with differentiated practice.
Outputs	Increased EL participation in math discourse. Measurable growth in academic language.
Outcomes	Improved EL performance on high-stakes math and language assessments.

Relationship Between Language and Content Learning

Conceptual understanding of deep, rich mathematical ideas is built through discourse (National Council of Teachers of Mathematics, 2014). Whether it is independent reading, listening, or discussion with peers, the negotiation of meaning happens with and through language. Echevarria (2017) notes, "Language is at the heart of teaching math. For English Learners, the relationship is critical because these students are learning mathematics while they are acquiring the language in which mathematics is being taught." Communication about mathematics deepens understanding (Heibert, 1997). Succinctly stated, "Mathematical understandings and language competence develop interdependently" (Zwiers et al., 2017).

Large organizations including the Council of the Great City Schools have reinforced the relationship between mathematical discourse, mathematics outcomes, and language development growth. The Council's report notes: "the processes of developing language and developing conceptual mathematical understanding are interdependent and symbiotic" (Council of the Great City Schools, 2016). The report goes on to explain that engaging in rich communicative activities related to mathematics improves both math proficiency and language proficiency. "Learning and leveraging mathematics language is essential to building conceptual understanding of mathematics ideas and processes" (Lord, MacDonald, & Miller, 2019).

Ellevation Math builds essential mathematics language, leveraging research-based strategies described below to drive both mathematics achievement and language growth. The learning experience is built around a problem-solving context in which age-appropriate characters engage in think-alouds, marrying the language and thought patterns essential to choosing from multiple representations, unpacking contextual problems, checking the reasonableness of answers, and other important practices of mathematics. By building language through a worked problem, Ellevation Math prepares students for their own engagement in rich, mathematical tasks that lend themselves to analysis, discussion, and reflection.

"Language is at the heart of teaching math. For English learners, the relationship is critical because these students are learning mathematics while they are acquiring the language in which mathematics is being taught."

Jana Echevarria in *Supporting English Learning in Mathematics Classrooms*

Direct Instruction of Academic Vocabulary

Building academic vocabulary is a significant contributor to the development of language and mathematical content knowledge. Robert Marzano has championed the impact of explicit vocabulary instruction with a focus on the relevance of vocabulary instruction to concept learning: "research by Stahl and Fairbanks (1986) indicates that student achievement will increase by 33 percentile points when vocabulary instruction focuses on specific words that are important to what students are learning" (Dean & Marzano, 2013).

Despite these clear and replicated findings about the impact of vocabulary instruction, The Center on Instruction notes that middle and high school content-area teachers "incorporate little, if any, systematic and explicit vocabulary instruction" (Francis et al., 2006). Why? There is limited time and space to teach foundational skills and concepts.

Providing precise and clear vocabulary instruction and the requisite number of exposures to new words is time-consuming. The Center on Instruction lists clear, required conditions: "effective vocabulary instruction must be frequent, intensive, systematic, and complex" (Francis et al., 2006). Given these conditions, a structured instructional program that can be efficiently and consistently implemented can effectively meet these conditions and avoid placing undue burden on teachers. The precision and consistency of language is especially important as students engage with multiple teachers over the course of their schooling.

If an EL has not reached proficiency by middle school, the more rigorous learning demands, combined with remaining language gaps, present a significant challenge (Hanover Research, 2017). Ellevation Math provides an important foundation for both building and assessing knowledge of the specific academic vocabulary essential for mathematics lessons. While some math programs include links to vocabulary definitions, and conversely, some vocabulary programs include a selection of math terms, there are no solutions that provide the intensive focus on contextualized language development that Ellevation Math delivers.

Rich, Meaningful Context

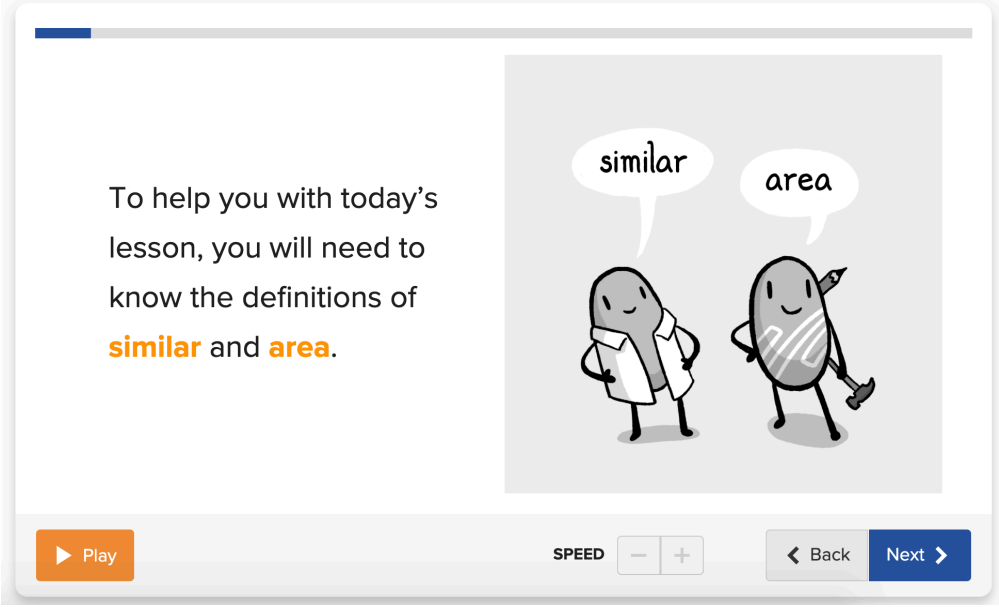
Vocabulary can be taught in a variety of ways. In the past, many teachers introduced word lists and had their students look up words in a dictionary prior to a lesson. This is typically described as decontextualized vocabulary instruction. The National Reading Panel meta analysis clearly notes that context is important for vocabulary instruction to be effective (National Reading Panel, 2000). In their "Framework for Raising Expectations", the Council of the Great City Schools criticized programs that use a decontextualized approach to language learning (Council of the Great City Schools, 2016). In Ellevation Math, key vocabulary terms are contextualized in a math scenario, as opposed to presented via word lists.

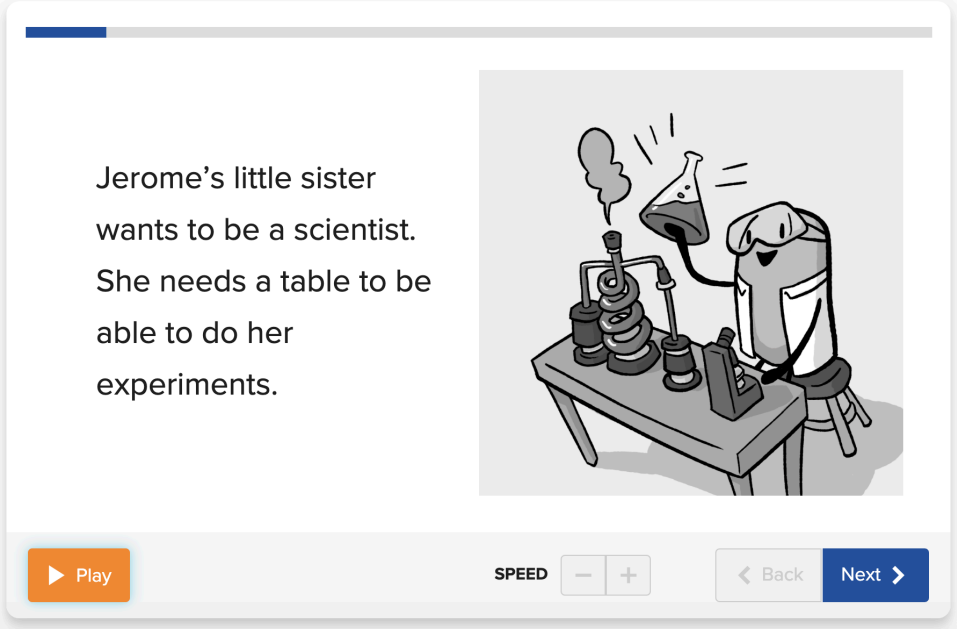
Presenting language in context is critical to both the thorough understanding of new language and the ability to transfer word learning to authentic instructional contexts. Despite over a decade of focus on vocabulary acquisition and its importance, word learning issues persist. The Center on Instruction report (Francis et al., 2006) notes: "While many ELs need to be taught words—both the label for a word and the concept behind the word—there are also many ELs who have a label for a word, but lack the deep conceptual knowledge about the word itself and the words that relate to it." To ensure that both definition and meaning are learned, context is key. In their description of effective vocabulary instruction, Graves et al. (2013) describes several studies that demonstrate that vocabulary instruction is more effective when it includes both a clear definition and a meaningful context. They conclude, "While simply having students work with definitions of words can improve their word knowledge, giving them both definitional information and contextual information has repeatedly proven to be a stronger approach."

In Ellevation Math, vocabulary is presented in a rich, problem-solving context during which friendly, relatable characters think aloud as they solve problems. Primers build on what students already know and use stories that relate to students' lives and experiences, like part-time jobs, waiting in the lunch line, or going to the movies, making it easy for students to connect with the content. They also showcase relevant applications of math in the real world by providing windows into where math is used in various careers and contexts. Context situates the new words at the sentence-level, providing exposure to syntax and usage.

This approach also puts the words in a cognitive context, showing where in the thinking process these fit. This think-aloud approach not only provides rich context that supports word knowledge but also facilitates transfer. The Center on Instruction (Francis, et al., 2006) notes, "under these 'think-aloud' conditions, students not only practice relevant academic language, but they also become increasingly aware of their own thinking, and their peers' thinking." Context also supports the rich, sense-making collaborative experiences present in student-centered classrooms (Walters et al., 2014). In a process-oriented content area like mathematics, this context is especially impactful.

By presenting new language in context, Ellevation Math also provides opportunities for multiple exposures to new terms and phrases. Each key word is repeated several times in the narrative of the Primer. A Confidence Question gives students active experience with new language. Glossaries and reference sheets provide additional word-learning resources. Each Primer ends with a Vocabulary Test that is both taken and reviewed to drive language exposure and accountability.





Grade-Level Concepts and Rigor

Math performance and scores have long been gatekeepers, beginning with the ranking of students starting in elementary school (National Council of Supervisors of Mathematics and TODOS: Mathematics for ALL, 2016). In fact, studies show that early math performance is a key predictor of later academic success, and better performance on math assessments is linked with opportunities for accelerated learning, such as advanced placement and gifted and talented classes (Mongeau, 2013). Even students who are assigned grade-level activities have stronger academic outcomes. In The New Teacher Project's 2018 report "The Opportunity Myth", students who started below grade level, yet worked on grade-level assignments, gained seven months of additional learning in a single year (The New Teacher Project, 2018).

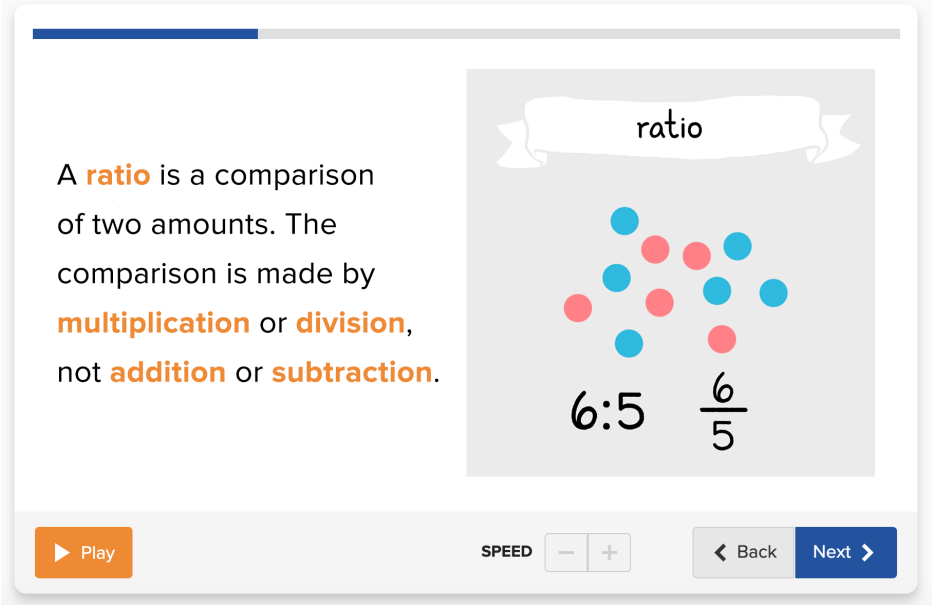
Rather than watering down math content, Ellevation Math makes grade-level content accessible by providing opportunities for modeled think-alouds and examples of mathematical reasoning.

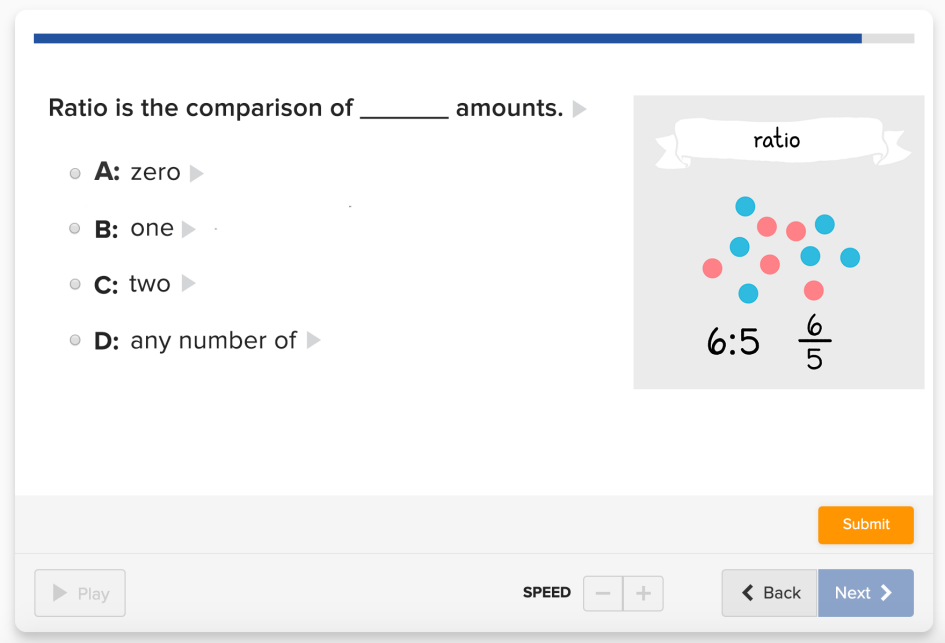
Many current interventions focus on building prerequisite math skills for students with unfinished learning. This leaves out the importance of balancing that essential catch-up work with a continued exposure to grade-level standards. Policy briefs like "The Iceberg Problem" highlight this inequity, and urge a balance (New Classrooms, 2011). Ellevation Math provides a critical resource for equipping multilingual students to engage in grade-level standards, providing access to the learning opportunities needed for long term success. How? Ellevation Math provides an accessible yet authentic introduction to both the academic language and rigorous concepts of middle school math. It is specifically designed to cover grade-level content standards. By giving students this equitable access to grade-level standards, the program makes it possible for teachers to assign grade-level content learning knowing language supports are in place.

Providing a resource for building mathematics alongside academic vocabulary leads to powerful outcomes. By using Ellevation Math, English Learners will be better prepared for the rigorous instruction of the math classroom. They arrive to class ready to engage, solve problems, and explain their thinking while utilizing new vocabulary. Implementing Ellevation Math also saves teachers time in the long run: by preparing students to access content before the instruction takes place, teachers reduce the need for intervention later on. When students are better able to engage in skill-building and class discussions, they are more likely to reach benchmarks and succeed on high-stakes math assessments. "The results showed that students who participated in more discourse sessions had both higher final course scores and higher odds of scoring at or above Proficient on the state assessments, after controlling for multiple covariates, including prior math achievement level and the levels of confidence, self-efficacy, and math mindset" (Choi & Walters, 2018). Ellevation Math gives students a

sheltered, non-judgemental online environment to learn and practice academic math vocabulary in context, preparing them for leveraging those words in authentic classroom settings.

Ellevation Math includes brief formative assessments to help teachers gauge student vocabulary learning, concept understanding, and confidence. This enables teachers to conduct differentiated whole-class and small-group lessons in a manner responsive with language readiness.





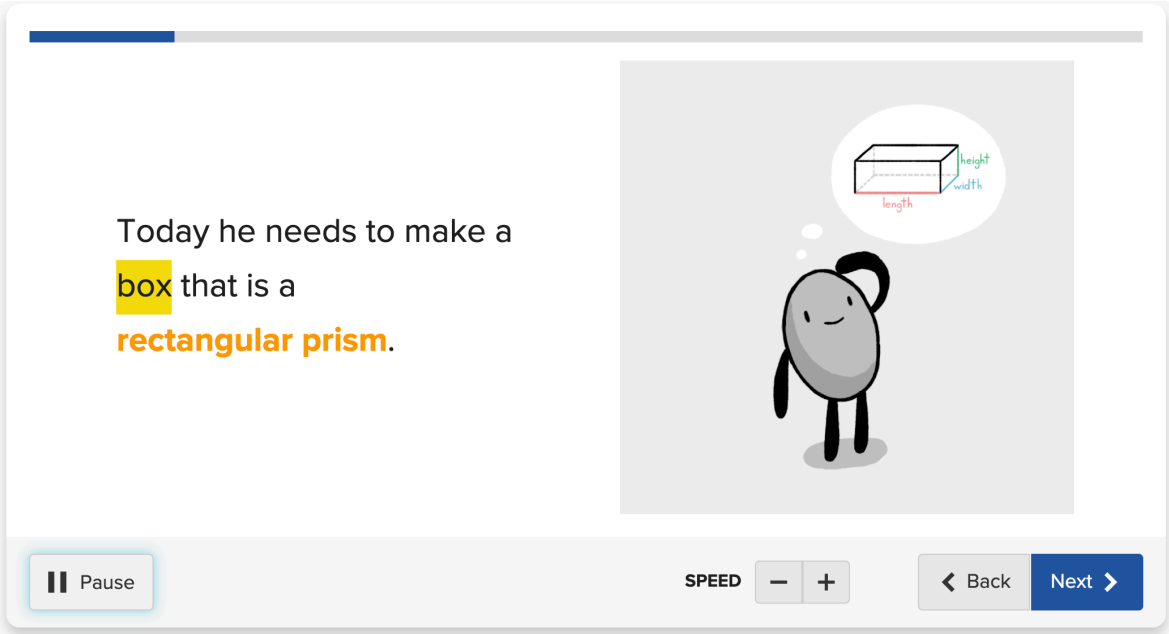
Comprehensible Input

While rich context supports language acquisition and application, new language and content is learned and acquired when the learner is able to clearly understand the input. The Center for Instruction (Francis et al., 2006) also emphasizes that "for the mathematics instruction to be effective for the ELL students in the classroom, it must first consist of comprehensible input."

Ellevation Math employs several comprehensible input strategies, including:

- **Visual Anchors:** The program uses visual restatements, drawings and icons that show in visual form what is communicated in the text. These are referred to as visual anchors. These are consistent across Primers and leveraged in reference sheets, assessments, and other learning resources.
- **Read With Me**: Content is conveyed using multiple inputs including human narration and synchronized text highlighting. These supports help learners connect what they hear to what they read. This promotes general reading skills and is particularly beneficial to students whose first language does not follow the left-to-right directionality found in the English language.

These tools are available to students to adjust the pace of content and/or review previous content, enabling them to practice self-monitoring and agency.



Differentiation by Language Proficiency Level

Differentiation has a long history of research in education. Thought leader Carol Ann Tomlinson (2016) emphasizes being proactive as a key component of differentiation. The automated differentiation capabilities in Ellevation Math bring this important tenet to life.

ELs are a heterogeneous group. They represent a variety of home languages, cultures, interests, and other attributes. Additionally, each student is at a specific point in their trajectory of language learning. All states define language proficiency levels as a way to measure language growth. The educational consortium of state departments of education, WIDA, notes that language expectations "should be differentiated for ELs based on their English proficiency levels and other relevant background factors" (WIDA Consortium, 2012). This variety is inherent within each classroom, creating a significant challenge for teachers who need to address varying needs through differentiation. Differentiation is a key tenet of research-based instruction for ELs (August, McCardle, & Shanahan, 2014).

Ellevation Math has a unique capability to provide learning supports differentiated by student language proficiency. Proficiency levels are synchronized to Ellevation from student data systems. Then, the appropriate supports are displayed to students accordingly. This ensures that beginners encounter appropriate supports, and that students at advanced language proficiency levels have those scaffolds removed so they can engage in more linguistically rigorous practice on par or exceeding their Native English Speaking peers.

The ability of Ellevation Math to provide automatic differentiation will make a profound difference in truly providing learning experiences that are in the students' zone of proximal language development. In addition, streamlined, automatic differentiation addresses the disparity between the benefits of differentiated instruction and teachers' time constraints in effectively implementing differentiation. In a nationwide survey, eighty-three percent of teachers stated that differentiation was "somewhat" or "very" difficult to implement (Loveless, Farkas, & Duffett, 2008). By embedding differentiation, Ellevation Math helps teachers follow best practice with less difficulty.

Conclusion

Multilingual students have rich cognitive and linguistic assets that can enrich our communities and contribute to our nation's long-term goals for building innovation and impact in STEM industries. Ellevation is committed to helping multilingual students achieve their highest aspirations, and with Elevation Math, we can support students and teachers in reaching these goals. Ellevation Math is aligned with the policy and thought-leadership that drives equitable access to rich, rigorous content and deep, engaging learning experiences. The program incorporates the most recent research in mathematics and language learning in the design of the learning experience and teacher tools and resources. When paired with the rich data and insights in Ellevation Platform and the research-based teacher development in Strategies, Ellevation Math creates a comprehensive and effective solution for driving math achievement.

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