STEMscopes™ MATH

STEMscopes Math

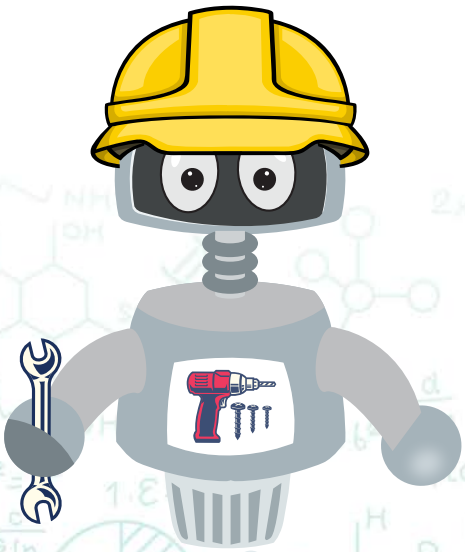
Research & Philosophical Approach

LEARNING WITHIN REAL-WORLD, RELEVANT CONTEXT

STEMscopes Math Elements

In STEMscopes Math, student learning is rooted in real-world scenarios. The **Hook , Explore Activities,** and **Problem Based Tasks** engage students throughout the learning process in relevant situations where the math skill is needed.

Math Today! provides students with authentic news media from the Associated Press. Students are prompted to see how math is involved in various events around the world.



Research Summaries and Excerpts

One of the major issues within mathematics classrooms is the disconnect between performing procedural skills and when to use them in everyday situations. Students should develop a deeper understanding of the mathematics in order to reason through a situation, collect the necessary information, and use the mechanics of math to develop a reasonable answer. Providing multiple experiences within real world contexts can help students see when certain skills are useful.

"If the problem context makes sense to students and they know what they might do to start on a solution, they will be able to engage in problem solving."

(Carpenter, Fennema, Loef Franke, Levi, and Empson, 2015)

CONCEPTUAL UNDERSTANDING AND NUMBER SENSE

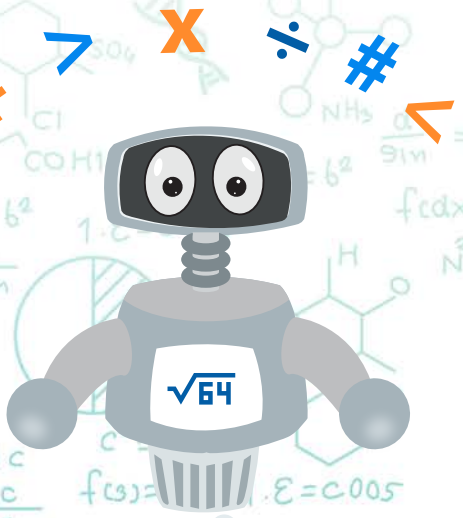
STEMscopes Math Elements

The **Fact Fluency** program develops student automaticity with basic facts by building on their conceptual understanding of the four operations.

The **Explore Activities** focus first on conceptual understanding before moving on to abstract representations and processes.

In order to reason mathematically, students must understand why different representations and processes work. After developing this understanding in the **Explore**, students complete the **Decide and Defend** reasoning assessment where they are prompted to write out an argument using mathematical evidence and reasoning.

If a student has not yet achieved mastery, teachers can use the **Small Group Intervention** activity to revisit the conceptual foundation in order to build student understanding.



Go to stemscopes.com/math to learn more

Research Summaries and Excerpts

Students are more likely to retain and apply mathematics if they understand how and why different procedures work. When students understand why they are doing something, they are more likely to compute accurately and determine if an answer is reasonable. Conceptual understanding leads to the development of students' number sense. Number sense involves the ability to estimate, work with numbers mentally, and spot unreasonable answers. Students with deep conceptual understanding and strong number sense will have the tools they need to reason mathematically and solve problems in the real world.

"When learning arithmetic processes, children focus on the symbols and tend to see arithmetic as doing something to those symbols to get right answers."

(Burns, 2007)

"…having mastered arithmetic procedures is not a sufficient indicator that children truly understand the concepts that symbolic manipulations represent. It does not guarantee that they will be able to use those concepts to solve problems" ***(Burns, 2007).***

"…students are often presented with the message that there is a particular way in which mathematics must be done--that there is only one right answer and only one right way to find that answer. The emphasis is on learning a set procedure rather than on conceptual understanding. Delvin in his book *The Math Instinct* (2005) states 'The problem many people have with school arithmetic is that they never get to the meaning stage; it remains forever an abstract game of formal symbols.'"

(Sammons, 2010).

Computational errors are commonly derived from a missed step in a formal procedure. Learning to compute in isolation leads students to focus on the operation rather than what makes sense within a situation.

"The implication from the examples of arithmetic errors is that children rely on recipes rather than reasoning. Following recipes results from learning arithmetic as a collection of specific methods used to arrive at answers, rather than thinking about what makes sense."

(Burns, 2007)

"A third guideline, one that might not be so obvious, is that instruction can emphasize conceptual understanding without sacrificing skill proficiency."

(NCTM, 2000)

"If students have more opportunities to construct mathematical understanding, they will construct such understanding more deeply and more often. But at what cost? Will they fail to master facts and skills? The research evidence suggests that it is not necessary to choose between these two types of learning. The research programs generating this evidence include a balance of invention, demonstration, and practice. Students have opportunities to develop and present new procedures; listen to the shared procedures of others, including their teachers and peers; discuss why different procedures work; and practice procedures that they understand. Those who study learning, including many teachers, are not surprised that understanding does not detract from skill proficiency and may even enhance it. If you understand how and why a procedure works, you will probably remember it better and be able to adjust it to solve a new problem. If you memorize a procedure and do not have a clue about how it works, you have little chance of using it flexibly."

(NCTM, 2000)

CRA APPROACH

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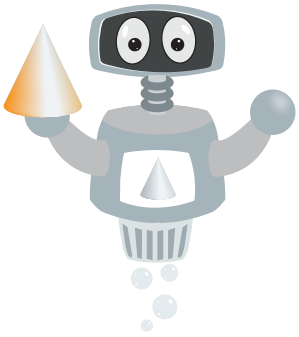
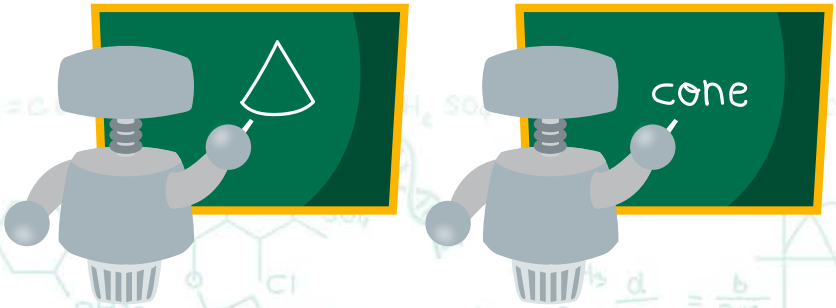
As students progress through the **Explore Activities**, they will transition from hands-on experiences with concrete objects to representational, pictorial models, and ultimately arrive at symbolic representations, using only numbers, notations and mathematical symbols.





Research Summaries and Excerpts

CRA stands for Concrete - Representational - Abstract. When first learning a new skill, students should use carefully selected concrete materials to developing their understanding of the new concept or skill. As students gain understanding with the physical models, they start to draw a variety of pictorial representations that mirror their work with the concrete objects. Students are then taught to translate these models into abstract representations using symbols and algorithms.

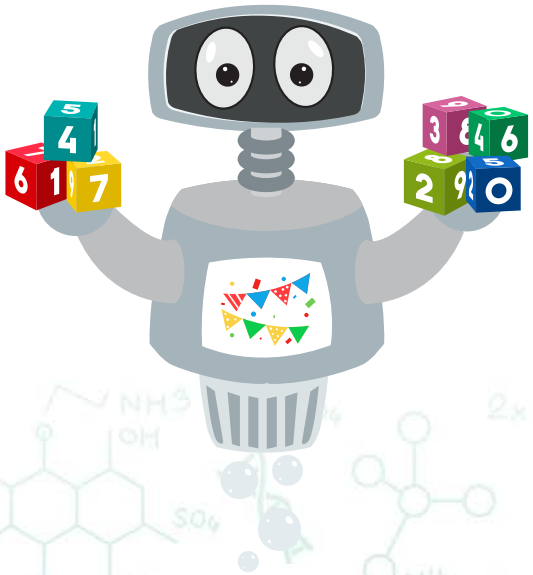
> The overarching purpose of the CRA instructional approach is to "ensure students develop a tangible understanding of the math concepts/skills they learn."
>
> ***(Special Connections, 2005)***

> Using their concrete level of understanding of mathematics concepts and skills, students are able to later use this foundation and add/link their conceptual understanding to abstract problems and learning. Having students go through these three steps provides students with a deeper understanding of mathematical concepts and ideas and provides an excellent foundational strategy for problem solving in other areas in the future.
>
> ***(Special Connections, 2005).***

USING MANIPULATIVES

STEMscopes Math Elements

The **Hook** and **Explore Activities** provide thorough facilitation strategies for teachers to use manipulatives in their classroom in a way that is engaging and meaningful. The way these activities are scaffolded allows students to reduce their dependence on manipulatives over time.



Research Summaries and Excerpts

Concrete items are meant to be used as a tool that students can manipulate in order to explore mathematical concepts. As students develop proficiency, they will rely less on the concrete materials and become capable of using mental models and abstract representations.

"Just as we say that a picture is worth a thousand words, there is no substitute for firsthand concrete experiences. Materials provide children physical models with which they can interact and which help them form mental models that they can then connect to abstract symbolic representations."

(Burns, 2007)

"Over the past four decades, studies done at all different grade levels and in several different countries indicate that mathematics achievement increases when manipulatives are put to good use.

(Canny, 1984; Clements and Battista, 1990; Clements, 1999; Dienes, 1960; Driscoll, 1981; Fennema, 1972, 1973; Skemp, 1987; Sugiyama, 1987; Suydam, 1984)."

COLLABORATIVE EXPLORATION

STEMscopes Math Elements

Most of the elements in STEMscopes Math involve student collaboration and require a learning community within the classroom. In the **Hook** and **Explore Activities**, students work together to gain an understanding of a new math concept. These activities include teacher guidance for facilitating math discussions. In the **Problem Based Task**, students work together to use the new skills they just learned. Each of these elements prompts students to communicate their understanding and evaluate the reasoning of others.

Research Summaries and Excerpts

Our curriculum allows students to work together and learn from each other with the teacher as the facilitator of their learning. As students work together, they begin to reason mathematically as they discuss their ideas and debate about what will or will not work to solve a problem. Listening to the thinking and reasoning of others allows students to see multiple ways a problem can be solved. In order for students to communicate their own ideas, they must be able to reflect on their knowledge and learn how to communicate this knowledge.

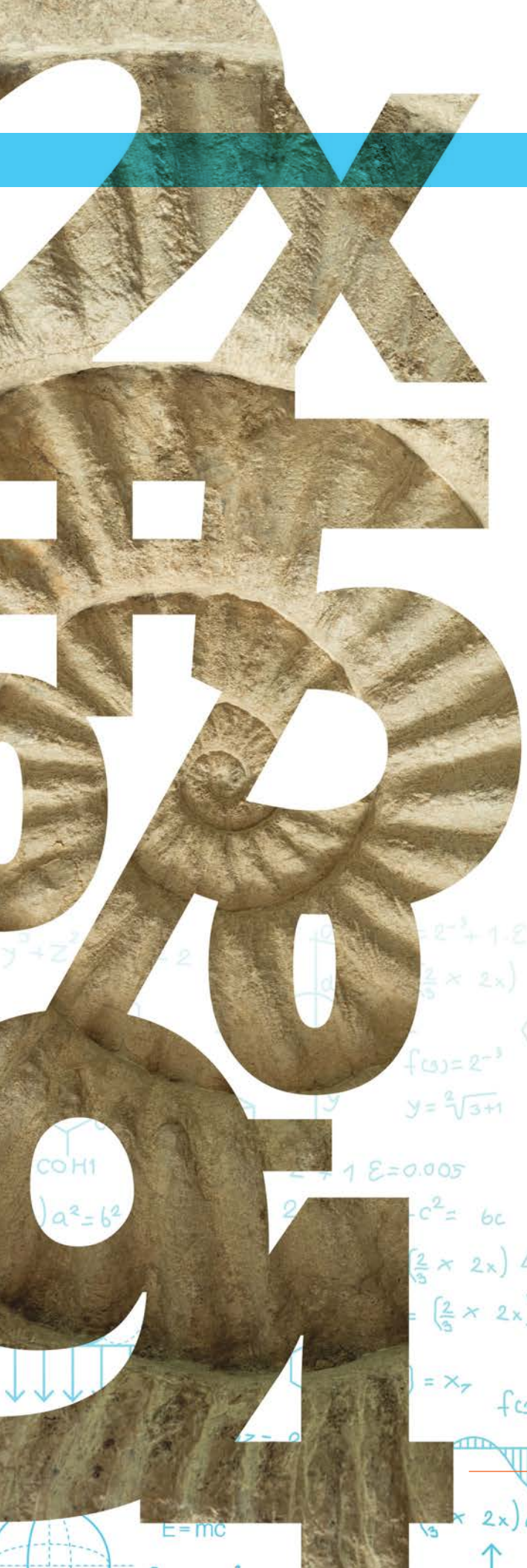
Working collaboratively is more reflective of the real world situations that students will experience outside of school.

"Incorporate communication into mathematics instruction to help students organize and consolidate their thinking, communicate coherently and clearly, analyze and evaluate the thinking and strategies of others, and use the language of mathematics."

(NCTM, 2000)

"From a cognitive perspective, collaboration can promote conceptual understanding as students have the opportunity to share their thinking, consider alternate conceptions and discrepancies, and make sense of various representations or abstractions" (Schwartz, 1999) Groupwork is an effective technique for achieving certain kinds of intellectual and social learning goals. It is a superior technique for conceptual learning, for creative problem solving, and for developing academic language proficiency."…"It will teach skills for working in groups that can be transferred to many student and adult work situations."

(Cohen & Loten, 2014)

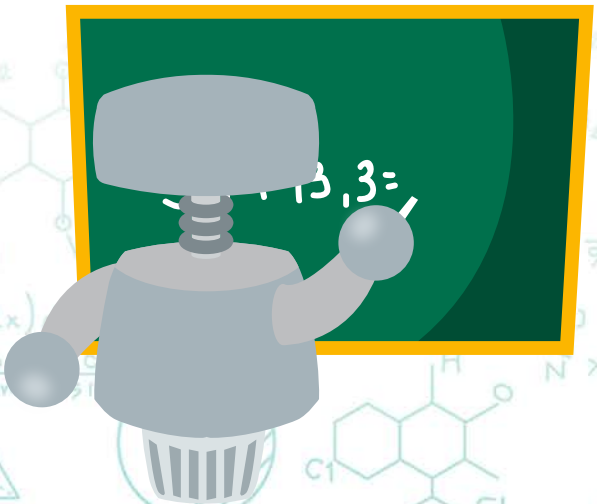


COMPUTATIONAL FLUENCY

STEMscopes Math Elements

Students are provided with multiple opportunities to practice skills using a variety of strategies. The **Show What You Know** activity allows students to demonstrate understanding and practice a new skill after exploring the concept.

The entire **Elaborate** section provides several options for student practice. The **Spiraled Review** activities engage students in practice through games or independent activities. In **Math Stories**, students will practice finding the information they need to solve a problem while practicing the new skill. The **Problem Based Task** provides a more rigorous opportunity for students to practice within real-world context. In each practice opportunity, students have the flexibility to use different processes and strategies to reach a solution. Students will develop fluency as they become more efficient and accurate in solving problems.



Research Summaries and Excerpts

Fluency is not limited to the memorization of facts or procedures to follow. As students gain an understanding of a variety of math concepts, they are building their mathematics "tool kit". Being fluent in math means knowing when and how to effectively use tools from your mathematics "tool kit".

> "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."
>
> ***(NCTM, 2014)***

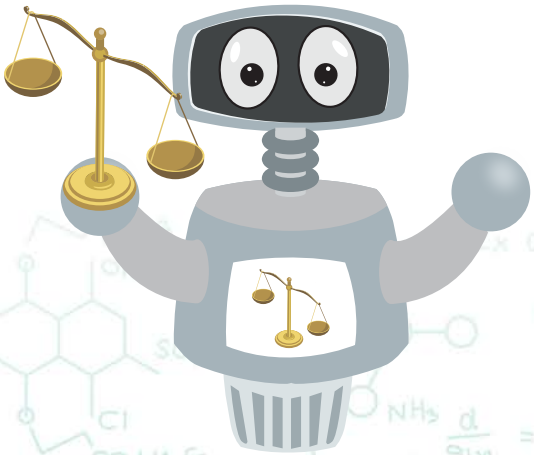
> "Procedural fluency is the ability to apply procedures accurately, efficiently, and flexibly; to transfer procedures to different problems and contexts; to build or modify procedures from other procedures; and to recognize when one strategy or procedure is more appropriate to apply than another."
>
> ***(NCTM, 2014)***

PROMOTING EQUITY

STEMscopes Math Elements

Implementing STEMscopes Math in the classroom provides access to high quality, challenging learning opportunities for every student. The activities within the program are scaffolded and differentiated so that all students find the content accessible and challenging.

The emphasis on collaborative learning within the STEMscopes program promotes a sense of community in the classroom where students can learn from each other.



Research Summaries and Excerpts

Teachers are encouraged throughout our curriculum to allow students to work together as they make sense of mathematics concepts. Allowing groups of students to work together to solve real world tasks creates a sense of community and sets a common goal for learning for all students.

Curriculum tasks are accessible by all ability levels while giving all students opportunities to explore more complex mathematics. It removes the polar separation of being a "math person" or not and gives opportunity for all students to engage in math and make sense of it.

"Teachers can build equity within the classroom community by employing complex instruction , which uses the following practices.

(Boaler & Staples, 2008):

- Modifying expectations of success/failure through the use of tasks requiring different abilities
- Assigning group roles so students are responsible for each other and contribute equally to tasks
- Using group assessments to encourage students' responsibility for each other's learning and appreciation of diversity"

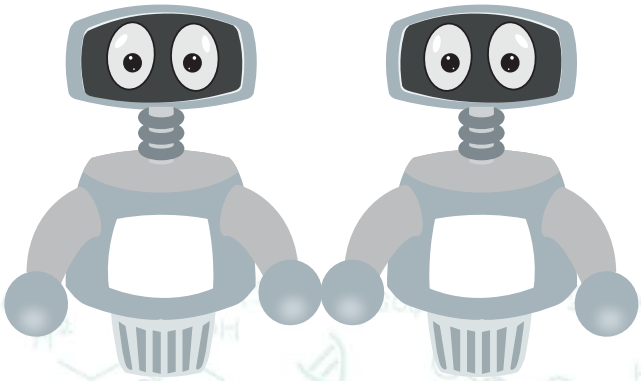
"A clear way of improving achievement and promoting equity is to broaden the number of students who are given high-level opportunities." (Boaler, 2016)
All students should have the opportunity to receive high-quality mathematics instruction, learn challenging grade-level content, and receive the support necessary to be successful. Much of what has been typically referred to as the "achievement gap" in mathematics is a function of differential instructional opportunities.

(NCTM, 2012)

CONTENT KNOWLEDGE OF TEACHERS AND PARENTS

STEMscopes Math Elements

STEMscopes Math provides **Content Support** for teachers or parents who need additional background knowledge in order to fully support their student's understanding. This element will include why a concept is being taught a certain way by explaining what the students have already learned and giving insight to the concepts students will learn next.



Research Summaries and Excerpts

The ability of teachers and parents to help students understand math is limited by their own basic understanding. Many teachers and parents learned math differently than today's students and may need help understanding why math instruction is different than it used to be. The models and strategies presented may seem foreign to teachers and parents.

> Our own content knowledge affects how we interpret the content goals we are expected to reach with our students. It affects the way we hear and respond to our students and their questions. It affects our ability to explain clearly and to ask good questions. It affects our ability to approach a mathematical idea flexibly with our students and to make connections. It affects our ability to push each student at that special moment when he or she is ready or curious. And it affects our ability to make those moments happen more often for our students.
>
> ***(NCTM, 1999)***

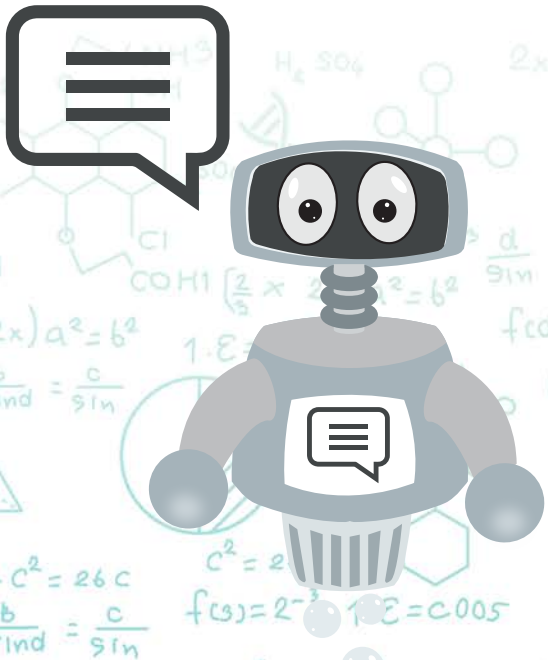
> Teachers need to explain the full scope of math instructional goals to parents, stated in the context of what children require for success in higher in higher education in our changing society. The world differs greatly today from when parents were in elementary school; the technological explosion has affected all areas of everyone's life. To cling to what was suitable when parents were in school is clinging to nostalgia rather than examining what is currently essential. Professional educators have the job of reeducating parents, not just complying with demands that are obsolete.
>
> ***(Burns, 2007).***

BUILDING ACADEMIC LANGUAGE

STEMscopes Math Elements

STEMscopes Math provides multiple opportunities for students to informally communicate their ideas with their peers and their teacher as well as opportunities to share their thoughts and reasoning in written form. The **Explore Activities** include facilitation for the teacher on how to attach academic vocabulary to the student's experiences during instruction. These activities also include discussion prompts for the teacher to guide students in communicating their thoughts using academic language. The embedded **ELPS Strategies** can help support english language learners as they acquire new vocabulary.

The **Picture Vocabulary** presentation is a support tool for teachers to represent new vocabulary with a picture and student friendly definition.



Research Summaries and Excerpts

Students learn academic vocabulary by attaching new words to prior knowledge and experiences. Students need opportunities to communicate using the academic vocabulary in order to become proficient at communicating on this level.

> Learners solidify and deepen their knowledge when they are able to consolidate the information across sources and experiences. During this process, they build schema—organized patterns of facts and concepts. Content vocabulary learning also requires extensive schema building, which is best accomplished by giving students opportunities to consult materials and interact knowledgeably with one another.
>
> ***(ASCD, 2015)***

> Academic language is believed to be one of the most important factors in the academic success of ELLs, and it has been increasingly cited as a major contributor to achievement gaps between ELLs and English-proficient students.
>
> ***(Francis, Rivera, Lesaux, Kieffer, & Rivera, 2006)***

> Language, in other words, is how we think. It's how we process information and remember. It's our operating system. Vygotsky (1962) suggested that thinking develops into words in a number of phases, moving from imaging to inner speech to inner speaking to speech. Tracing this idea backward, speech—talk—is the representation of thinking. As such, it seems reasonable to suggest that classrooms should be filled with talk, given that we want them filled with thinking!
>
> ***(ASCD, 2008)***

> There are important differences between the language that we use in everyday conversations and the language used in school (Westby, 2012), where everyday conversations are originally used to achieve daily tasks and share personal information. Academic language includes a different set of words, more complex grammatical structures and different text organization to express content which describes complex relationships.
>
> ***(Zwiers, 2008)***

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Connecting Research with Practice, NCTM

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Practical guidelines for the education of English language learners: Research-based recommendations for instruction and academic interventions, Francis, D., Rivera, M., Lesaux, N., Kieffer, M., & Rivera, H. Guided Math, Laney Sammons