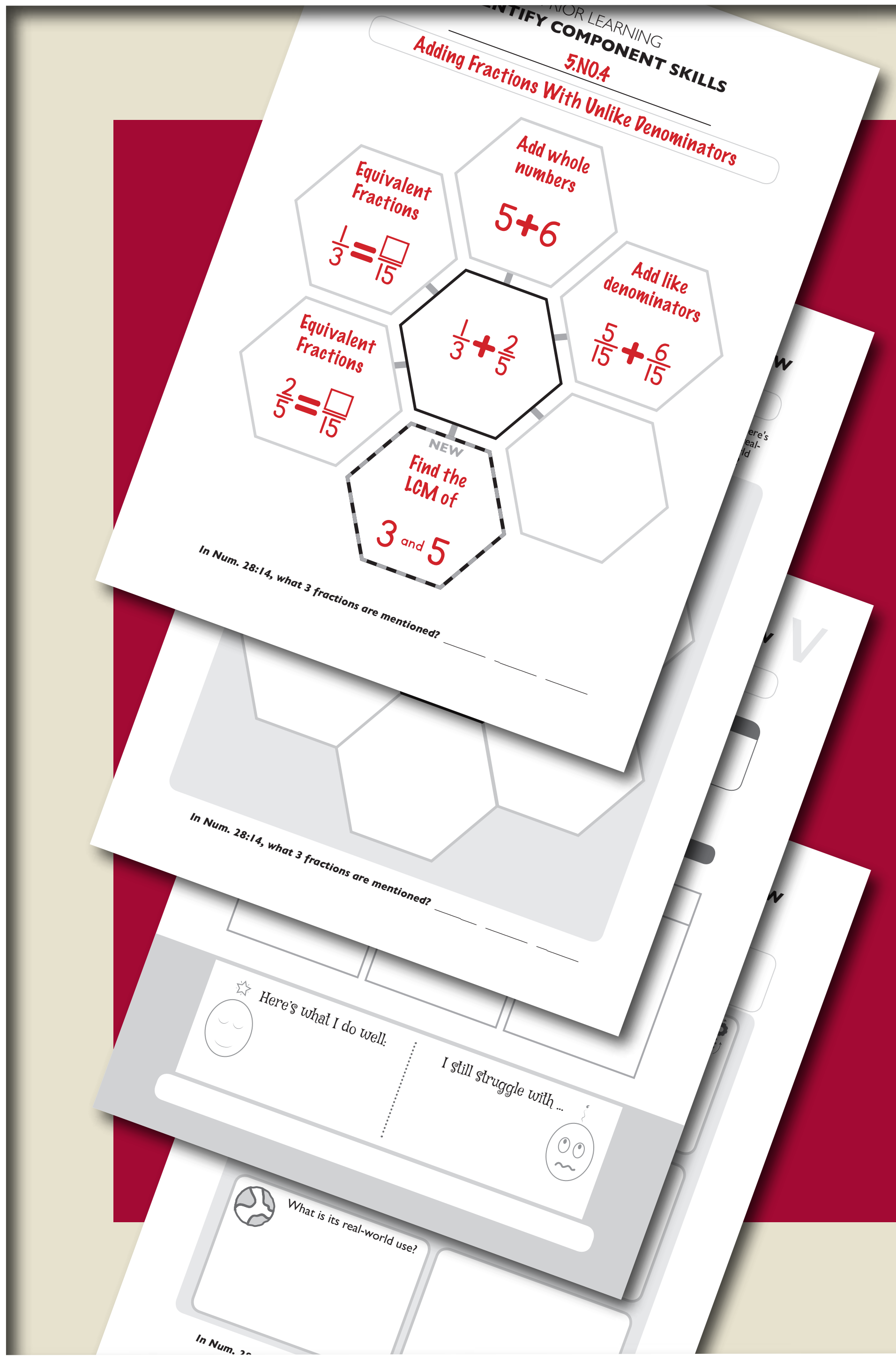
Elvis Agard

# Using Graphic Organizers to Activate Prior Learning in Mathematics




Student engagement is a common part of most instructional delivery approaches. Teachers know well the lure of high-impact videos, hands-on activities, and charming games—each engineered to create excitement and generate student interest. Graphic organizers are also effective tools teachers can use to help stimulate learners' thinking about prior knowledge while simultaneously evoking interest. Organizers help students engage in reflective practice. As part of reflective practice, teachers can employ graphic organizers to help students make faith connections as they learn.

## Engagement Models

The 5E Instructional Model is used to teach science and mathematics. At its core, the model seeks to engage

## Chart 1. 5E and 7E Instructional Model Comparison

| 5E Instructional Model | 7E Instructional Model |
|---|---|
| **Engage**<br>Capture learners' attention through activities, videos, anticipatory sets, etc. | ***Elicit – Connect new concepts to prior knowledge and past experiences.***<br>**Engage** |
| **Explore**<br>Introduce new concepts and use manipulatives, kits, assignments, teamwork, discussions, etc., to help learners delve into the topic. | **Explore** |
| **Explain**<br>Provide opportunities for learners to communicate and express what the concepts mean. | **Explain** |
| **Elaborate**<br>Present additional information and activities that will allow learners dig deeper for meaning and strengthen their skills. | **Elaborate** |
| **Evaluate**<br>Determine whether the concepts have been learned. | **Evaluate**<br>***Extend – connect new learning to related concepts or apply concepts to related subjects.*** |
| | ***Added to the 7E Model** |

students in discovery, building on their natural curiosity while strengthening critical thinking and problem-solving skills. The five "E's" are *Engage, Explore, Explain, Elaborate,* and *Evaluate.*[1] With "Engagement" being the first stage of the 5E Instructional Model, an unintended consequence arose: Adherents were likely to omit activating prior learning, concentrating only on piquing learner interest.[2] Its later expansion, the 7E Model, purposed giving equal weight to that easily overlooked step. The solution, which carefully avoided making the second model appear to be a successor to the first, deemed the activation of prior understanding an intimate part of the first stage *(Engage)*[3] (see Chart 1).

This drawing out of the student's academic memory, an almost universally agreed-upon element of effective teaching, is present in learning-process theory, cognitive-development theory, attribution theory, and cognitive perspectives of learning.[4] Embraced by so many schools of thought, it has become the recognized precursor to introducing new ideas. Why? It prepares the mental framework, the schema—that cognitive structure the mind needs to make sense of new information by relating known ideas to old concepts.

An Internet search reveals many creative strategies for activating this recall. Not a few involve versions of brainstorming, anticipatory guides, collaborative sharing, and the ever-popular, KWL chart (**K**now, **W**ant to Know, **L**earned).[5] But in my admittedly less-than-exhaustive search, among that family of graphic organizers renowned for its broad application and visual-verbal blending, why should the KWL chart seemingly stand alone as the tool to prod prior knowledge? Or, to orient the question toward our discussion, which graphic organizers specifically address students' previous learning in mathematics? Since graphic organizers have been used to help both students with limited English proficiency and students with learning disabilities, a branch of graphic organizers that help target each student's prerequisite capabilities in mathematics will likely address the needs of a broad audience of learners.[6]

In my attempt to create several of these, I established the criteria for the final products using these guidelines:

The organizers would do the following:

- Map the prior skills needed to learn a new topic;
- Relate old problems to new problems;
- Identify previously learned problem-solving steps;
- Include elements of reflective learning; and
- Make a faith-based connection.

I wanted these organizers to be flexible enough to accompany other strategies for stimulating student recall, while also doubling as stand-alone tools if needed. Two categories of products will be discussed in this article: organizers for mapping component skills, and organizers for identifying related problems and necessary problem-solving steps.

### Mapping Needed Skills

Every mathematics topic has a set of component skills. Students will know some of these, while others will be new to them. Ideally, teachers will want to introduce only one novel skill at a time, thereby establishing a stepwise learning progression that sets a tolerable pace for most learners. In order to identify these skills, the **Identify Component Skills** organizer offers suggestions for creating organizers suitable for the teacher and student, respectively.

*The Teacher Resource*

The **Identify Component Skills** organizer presents an instructor's tool that allows for the mapping of associated prior skills and new skills expected for a specific topic at a particular grade level. One way to do this would be to search preceding standards to identify building blocks relevant to the current topic. For example, adding fractions with like denominators is a precursor to adding fractions with unlike denominators. The foundational standards for these topics may extend across grade levels, or they may be imbedded within previously encountered standards for a single grade level.

Another approach would be to study the steps leading toward solving the new problem, flagging both those that students should already have learned, as well as the new skills to be introduced. Here is one example: Adding fractions with unlike denominators could reveal these prior skills: (a) finding equivalent fractions, (b) reducing fractions to their simplest forms, (c) adding whole numbers, and (d) adding fractions with like denominators. The new skill might be to find the lowest common multiple, or, if that skill has already been mastered, combining all these prior skills in proper sequence to produce the sum.

*The Student Resource*

The blank student version prompts the learner to brainstorm skills he or she thinks would be useful in solving the new problem. Comparing this process to the imagery of building a brick wall, it becomes clear that knowledge builds on itself, brick by brick. Because these strategies are used in tandem with cooperative learning and sharing strategies, the teacher does not intervene in the brainstorming but rather encourages teams of students to provide reasons for their choices.

## Relating Old Problems to New

The three types of organizers discussed below can be used to help learners activate prior knowledge by revealing what they already know about a topic. Teachers can use these approaches to help learners relate old (previously learned) strategies for problem-solving to new ones. They can also be used to help identify and correct misconceptions.

*1. "Six Things I Think I Know" Organizers*

Having learners reveal what they think they know about a topic is the first part of a KWL chart. The graphic organizers titled **Six Things I Think I Know** ask students to tell what they know about a problem, whether that means relating the problem to a related previously studied topic, or sharing a fact relating to the new topic. Because these organizers are specifically tailored for mathematics instruction, they include prompts to draw pictures of what the problem looks like, describe the problem's component parts, suggest a real-world context for the problem, and show how to solve the problem.

*2. "Reminds Me of" Organizers*

Often, but not always, new problems look strikingly similar to old counterparts except for a singular twist; thus, they are also solved similarly except for a singular twist. Exploiting this as a learning advantage is the purpose of the **Reminds Me of . . . .** organizers.

Consider, for example, the new problem, $-\frac{1}{3}+\frac{2}{5}$. The student might list the related old problems as $\frac{1}{3}+\frac{2}{5}$, -1+2, or -3+5. If the teacher provides additional prompts to encourage the students to solve the old problems they identify, he or she can identify possible misconceptions in the problem-solving steps that might be replicated when students solve the new problem. Addressing misconceptions is crucial to the learning process, since prior knowledge may include application errors that can impede the student's ability to move forward with new learning.

Conditionally, if students show proficiency in the old steps, this mode of engagement has the corollary benefit of relating so closely to the *Explain* stage of the learning cycle (where the student receives direct how-to instruction) that it can maximize the time available to learn the newly introduced problem-solving step. The significant difference between these stages is the limit on teacher intervention. When done in groups, it is the students who collaboratively clarify the steps as they share knowledge; the teacher facilitates the engagement and records misconceptions for later clarification.

> **The three types of organizers discussed here can be used to help learners activate prior knowledge by targeting what they already know about a topic. Teachers can use these approaches to help learners relate old (previously learned) strategies for problem-solving to new ones.**

*3. "U Should Know" Organizers*

By showing how to relate old problems to new ones, we have already seen how to identify students' knowledge of previously learned problem-solving steps. The approach above, however, relies heavily on each student's ability to perceive the connections, a feat possible only because the problems are visual twins. It will not always be obvious to the learner what prior knowledge he or she might need to solve a new problem.

Consider, for example, the problem, $\frac{3}{4}+\frac{6}{15}$. Seen for the first time, it does reveal the need to reduce $\frac{3}{15}$ and $\frac{6}{4}$ to their respective simplest forms. The use of the distributive property to generate rules for multiplying integers is an even more obscure example. It will likely not be apparent that the new problem, 3x(-2) is related to 3(5-2) from which we develop the rule, "a positive multiplied by a negative yields a negative." For these, the expected prior learning would have to be made explicit. The **U Should Know** organizers permit the teacher to give that direction, then step back to observe students' approaches to solving old problems, recording misconceptions to address at a later time.

### Reflective Learning

As students interact with the graphic organizers, instructors will want them to monitor their own experience so that the *meaning* of what they did becomes the topic of discussion.[7] If teachers accept that recall is the motif of each organizer, it becomes reasonable to have the students reflect on what they have recalled. For this reason, each organizer includes two prompts: "Here's what I do well:" and "I still struggle with. . . ." This provides valuable qualitative data not only for the student, but also for the teacher.

### Integration of Faith and Learning

Reflective learning also extends to creating opportunities for students to reflect on and recall God's Word. When it comes to seeking opportunities to integrate the Word of God, Christian teachers are rarely shy. Their ability to use curriculum as the vehicle to carry out this biblical mandate (Deuteronomy 6:6, 7) is the distinguishing feature of the Adventist

**Table 1. Five Approaches for Choosing Bible Texts That Connect With Mathematics**

| Approach | Example | Comment |
|---|---|---|
| 1. Offer encouragement. | Always give of your best (Ecclesiastes 9:10). | This Scripture selection is not topic-related and can be used as a default when it's difficult to find a direct math-Bible connection. However, it is to be followed by a discussion of why this is important. |
| 2. Reference the topic's use. | Topic: Counting. Can you count the stars? (see Genesis 15:5).<br>Topic: Multiplying. | Search for biblical instances when someone counted, calculated area or volume, etc.; discuss why to make a Jesus connection. |
| 3. Do a word play or study. | "What might multiply mean in the context of Deuteronomy 8:13?" | Search for biblical instances of the word that might have either a different meaning or the same meaning; discuss how to make a faith connection. |
| 4. Make an application. | Topic: Finding Volume. Calculate the volume of the ark of the covenant (Exodus 37:1)." | The students use the mathematics they learn to solve problems or explore phenomena present in the Bible. Discuss the phenomenon itself to make a faith connection. |
| 5. Make an analogy or other figurative connection. | Topic: Commutative Property. Just as the commutative property allows numbers to switch places, Jesus switched places with us, taking our sin, giving us His righteousness. (2 Corinthians 5:21). | Especially as the mathematics becomes more complex, this can be a most useful tool. Jesus used it extensively when telling parables. It is particularly useful for the middle- and upper-grade students, who need to be able to grapple with figurative language. |

ministry of education. Any document presented to a learner occasions the opportunity to integrate principles from the Bible. But many teachers wonder how to choose a text or passage of Scripture that relates to a mathematical topic. Table 1 offers five approaches. The choice of an approach should be guided by the goals of delivering an organic connection, one that is unforced because it easily relates to the topic at hand, using it in a way that provides insight into God's character or the plan of salvation.

Each graphic organizer concludes with a Bible text (which can be repeated for emphasis), and these texts can be presented in a variety of formats. They can be partnered with a teaser question, a fill-in-the-blanks prompt, a puzzle, or other creative approaches. The key is to stay within the mode of engagement, stirring wonder and interest in an age-appropriate manner

## Conclusion

Getting students to reflect on how their faith relates to their learning is not limited to mathematics instruction; the methods described here can be adapted to graphic organizers of any content area. But mathematics instruction, having its own nuanced requirements, can benefit from organizers that relate old problems to new ones, assess how well students understand previously learned problem-solving steps, and that map the component skills necessary to learn a new topic. Teachers of mathematics are encouraged to use and adapt these tools to assess their usefulness and ultimately to create their own (blank versions are included at this link). Whatever we do, it is crucial that we do not skip the stage of the learning cycle that accesses prior understanding but instead, view it as part of the engagement process. ✐

***This article has been peer reviewed.***

**Elvis Agard, MA,** *teaches Grades 6-8 at Berean Christian Junior Academy in Atlanta, Georgia, U.S.A. Mr. Agard has more than 20 years of experience in public and Christian education. He has taught in Barbados and the United States (Grades 3-12 and adult education) and has served as an administrator (principal and vice principal), and as a member of school- and district-level boards of education. Mr. Agard holds a Bachelor of Science in Mathematics and Computer Science from The University of the West Indies (Cave Hill, Barbados), and a Master of Arts in Educational Leadership and Administration from Andrews University (Berrien Springs, Michigan, U.S.A.). His areas of research interest include creating resources that close the gap between faith, learning, and achievement; and providing teachers with the tools to do the same.*

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