Cognitively Guided Instruction Transcript

1.1 Home: Cognitively Guided Instruction

Welcome to the Cognitively Guided Instruction course for Project SMART Making Mathematics Meaningful. A downloadable text version of the audio is available under the Resources tab in the upper right corner of the page.

At the end of the course, you will be required to complete a brief quiz to ensure you have met the objectives. If you score 80 or better, you will be issued a certificate of completion. If you score lower than 80, you will be able to review the course again and retake the quiz.

In this self-paced training, you will be provided an overview of Cognitively Guiding Instruction, or CGI, and learn which principles of CGI have been embedded within the Project SMART program.

1.2 Course Objectives

This course has two main objectives. Take a moment to read through them.

1.3 What is Cognitively Guided Instruction?

CGI is an approach to teaching the four operations of mathematics- addition, subtraction, multiplication and division. CGI uses a student's own mathematical thinking as the basis for instruction. It is based on the underlying assumption that children already possess an intuitive knowledge of mathematics. The teacher's role is to build on this knowledge so the student sees the connections between various problem solving strategies used. The intent is to provide a basis for learning basic mathematical concepts and skills with understanding and make sense of mathematics procedures, not just memorize them.

1.4 Characteristics of a CGI Classroom

The next few slides will walk you through the Characteristics of a CGI Classroom, and the role of both the teacher and the student within this classroom.

1.10 Characteristics in a Project Smart Classroom

As you reviewed the roles of the teacher and the student within a CGI classroom, you may have wondered which ones would be embedded within the Project SMART lessons.

You will definitely find many different problem solving situations you can present to your students.

The Project SMART program also provides teachers with the research-based curriculum needed to teach each grade band.

At the end of Unit 1 in each grade band, the teacher will find the CGI Activity, which lists the specific problem types and structures for the operations the students must know. Teachers will use this activity to provide structured time within the instructional day for problem solving.

In addition, teachers will be provided with questions that promote interactive class discussions about the various problem solving strategies the students use.

1.11 Developed Characteristics of the Project SMART program?

So, which roles are not explicit when using the Project SMART program?

The Project SMART program is not created with the intent to change a teacher beliefs about mathematics and problem solving. Ideally, teachers will have an open mind to the notion that students can solve problems without having a specific strategy taught to them.

Interactive class discussion topics are presented within the curriculum, but it's up to the teacher to ensure those discussions can occur in a safe, comfortable learning environment, giving students ample opportunity to listen to and discuss the strategies used when solving problems.

Because it takes time to learn the various problem types and strategies, Project SMART teachers are not expected to make decisions about the curriculum.

1.12 Compare and Contrast Three Main Differences

Take a moment to reflect on what you learned. Record three main differences you found between a CGI classroom and a traditional math classroom.

1.13 Aligning CGI with the Process Standards

Now that you have a little background knowledge about problem solving in a CGI classroom, let's see how closely CGI aligns with the Process Standards the state of Texas has implemented for engaging students in mathematics.

1.14 CGI in the Project Smart Program

Students are provided many opportunities to solve problems within the mathematics lessons in each Project SMART unit and for grades 1-8, there's a separate CGI Extension Activity located at the end of Unit 1. The problems in this activity are aligned to the specific CGI problem types and structures referred to earlier in the course. For students in Kindergarten, the CGI Problem types and structures are addressed only within the Project SMART lessons; there is no CGI activity for this grade level.

1.15 Addition and Subtraction Story Problems

Now it's time to take a look at the various problem types and structures we keep referring to. For this course, we have separated the four operations into two categories: Addition and Subtraction, and Multiplication and Division. The next segment of the course will focus on Addition and Subtraction, since this content is taught in Project SMART in all grade bands, K-8.

Children's ability to solve contextual situations, or story problems, depends greatly on whether they are able to understand and model the action or relationships in the problem.

For addition and subtraction problems, there are four basic problem types: join, separate, part-part-whole, and compare or, as it's known in grades 5-8, Additive Comparisons.

Contextual situations within a problem type all have the same type of action upon the quantities listed, or the same relationship between the quantities. Several distinct structures can be identified depending on which amount, or quantity, is unknown.

Before continuing in the course, you might want to download and print the Addition and Subtraction Problem Types and Structures chart. It can be found by clicking on Resources in the tope, right corner of the screen.

We will begin our study of the problem types with the first two: join and separate. Both of these problem types involve an action, for instance, something being taken away, something being given to someone, something lost, etc.

Join problems are problems in which the action in the story has objects or abstract concepts, like "miles," or "days" being joined together to make a total group.

Separate problems are those in which the action in the story has objects or concepts being separated, or taken away from a total group.

1.16 Join & Seperate Problem Types

By varying the location of the unknown, we can see a total of 6 different structures within these two problem types, 3 for addition and 3 for subtraction.

1.17 Result Unknown

Here are sample problems for Result Unknown.

Notice that Result Unknown means just that: the Result of what's happening in the story is unknown, so that's what the students are solving for.

Review the examples below and the corresponding number sentences that represent the action in the story.

1.18 Change Unknown

Now let's look at some examples of Change Unknown. This structure provides an initial or beginning amount, then an action happens that causes a change to the amount. The value of this "change"is unknown. The problem also provides the result, or final amount.

Review the examples below and the corresponding number sentences that represent the action in the story.

1.19 Start Unknown

Next we will review Start Unknown. This structure does not provide an initial or beginning amount, it simply states that there are "some" of the item being discussed- that's the unknown. The problem then has an action occur that causes a change. The amount of the change is provided in the problem, along with the final or resulting amount.

Review the examples below and the corresponding number sentences that represent the action in the story.

1.20 Part-Part-Whole

Now we will review the third problem type: Part-Part-Whole.

This problem type is very different from Join and Separate because there is no direct or implied action occurring in the story, and there is no change over time. In other words, nothing is taken away, bought, eaten, sold, etc. When we discuss these problems with students, we are focusing on the relationship of the quantities listed to each other.

Since there is no action both subsets, or parts, have equivalent roles in the problem. And because of this, there are only two structures of Part-Part-Whole problems.

The first structure provides both parts and asks the student to find the size of the whole. The second structure provides one of the parts and the whole, and the student has to determine the size of the other part.

Review the examples below and ensure you understand what is meant when we say "there is no action occurring in the story".

The fact that there is no action in the story does not mean that students cannot write a number sentence to show their specific solution strategy. We will discuss this topic when we finish reviewing our last problem type.

1.21 Compare

The next problem type within addition and subtraction is Compare. Compare problems, like part-part-whole problems, do not involve actions- like getting more cookies, or losing some toy cars. However, Compare problems are different from part-part-whole problems because they involve the comparison of two unique sets, rather than the relationship between a whole set and its parts. Because one set is being compared to the other, one set is labeled the "referent set" and the other is called the "compared set". The third piece in these problems is the difference between the referent set and the compared set, or the amount by which one set exceeds the other. Before looking at examples of these problem types, let's make sure you understand what is met by a referent set and a compared set.

1.22 Referent and Compared Set Example

In order to determine whether a problem is a Referent Unknown or Compare Quantity Unknown problem, we need to be able to determine which quantity in a problem is the Referent and which is the Compare Quantity. Let's look at an example to help clarify this.

Here's a basic sentence that describes the difference in quantity in a word problem about toy cars:

Steven has 4 more toy cars than Frank has.

Each quantity discussed will either be the <u>Referent</u> or the <u>Compare Quantity</u>. The roles are determined by the structure of the sentence. The word that determines the role is than. Steven's cars are being compared to Frank's cars. This makes Frank's cars the reference point–things are described according to their relationship with the size of the set of Frank's cars. We call that set that is being compared to the referent. The set of Steven's cars is described in terms of how different it is from the referent set. We call that amount (the amount in the set being compared) the compared quantity.

1.23 Examples of the three problem types

Now that you know the difference between the compare quantity and the referent quantity in a story, take a few minutes to read through the sample problems for the three compare structures. You will notice that, as with part-part-whole problems, there is not a number sentence written to model the action in the story, because there is no action occurring.

1.24 Solution Strategies

So far, we've discussed 11 structures for students to have experience with in order to become proficient with addition and subtraction situations.

As a reminder, join and separate problems can easily be modeled with counters and have a number sentence written that represents what is done with the counters, because there action happening in the story.

Part-part-whole and compare problems cannot be modeled as easily which means there is not one, specific number sentence that can be written to represent the modeling, because there is no action occurring.

How should students solve compare and part part whole problems?

So how are students expected to solve Compare and Part-Part-Whole problems? Well, just because they cannot model the story itself, doesn't mean they cannot model their solution strategy. The same is true for Join and Separate problems. There may be one number sentence that directly represents what's happening in the story, but another number sentence the student actually uses to solve the problem, because it makes more sense to them mathematically. The number sentence they use to solve the problem is referred to as a solution strategy.

1.25 Solution Strategies for Solving Problems

Children may demonstrate many different solution strategies when solving problems including: direct modeling, counting strategies and number fact strategies. This course will focus primarily on Number Fact strategies.

1.26 Example Structures and Solution Strategies

Let's look back at our structures and think about a few of them in terms of the solution strategy a child might use.

Read each example below then click on the "show me" button next to each example to see how each situation can be modeled.

This situation can be modeled and represented by the number sentence 3 + ___ = 8. However, children may use the solution strategy of starting with 8 and subtracting 3 from it, because of their knowledge of fact families. This is represented with the number sentence 8 – 3 = ___.

This situation can be modeled and represented by the number sentence ___ - 5 = 7. However, children may use the solution strategy of starting with 7 and adding 5 to it, or 7 + 5 = ___ They may also start with 5, the number eaten, and add 7, the number left, or 5 + 7 = ___.

1.27 Difficulty Levels

It's time to discuss the difficulty level of the various problems we have been learning about. Which structure and problem type do you think are easiest for students to solve? Which do you think are harder? Take a few minutes to review the chart below and think about which ones you would consider easy for students to solve and which would be more difficult.

Remember that problems which can be solved by direct modeling are generally easier for children, since they can actually see what's happening in the story. When you're ready, Click the button to review the classification by difficulty level.

We will address how the difficulty level of each problem impacts your instruction in Project SMART a little later in the course.

1.28 Connecting to the Project Smart Program

Now that we have walked through the various addition and subtraction problem types and discussed students' solution strategies, it's time to connect our learning to the Project SMART program.

Remember, CGI Problem types and structures are addressed within both the Project SMART lessons and the CGI Activity, found in Unit 1.

Let's talk about the lessons by grade band.

In kindergarten, students are identifying whether various types of contextual situations are joining or separating by identifying the action in the problem

In grades 1-2, students are identifying whether a contextual situation is joining, separating, comparing, or part-part-whole by identifying the action (or the relationship) within the problem

Grades 3-8 only address addition and subtraction problem types in the CGI Activity.

1.29 CGI Activity

In the CGI Activity, teachers may want to present each problem type individually to students so that they may have practice identifying the various structures within. For example, cut apart the cards on the Join page only and provide those to students as the first set to work with.

Ensure students are successful with the activity by introducing them to the problem type and structure prior to passing out the cards. Perhaps write the following chart on the board and review what it means with the students. For Grades 1-2, teachers can connect the information on the chart to a story problem taught within the Project SMART lesson.

Once the students are successful with this problem type, introduce them to the next type in the CGI Activity in the same manner. Keep in mind the difficulty level of each problem type and structure when your students are working through them, and provide support as needed, especially in understanding what the problem is saying. And remember to allow students to use manipulatives to model the problems. That step is critical for some students to understand what is happening in the story.

For a more challenging CGI activity, provide two or more sets or problem types for the students to work with at one time.

1.30 Overview Conclusion

This concludes the overview of addition and subtraction problem types and structures. If you are a teacher of Grades 3-8, the next segment of the course will focus on multiplication and division.

For grades K-2, it’s time for the end of course quiz.

1.32 Multiplication and Division

Multiplication and division involves several different problem types. Project SMART focuses on two of them: Grouping and Partitioning and Multiplicative Comparison.

Both types involve the same structures, so we will begin this segment of the course with the first type, grouping and partitioning.

Many multiplication and division problems involve grouping or partitioning quantities into equivalent sets. All grouping and partitioning problems involve three quantities:

- The number of groups (for example, 5 shelves)
- The number of items in each group (there could be 3 books on each shelf)
- The total

Varying the placement of the unknown in the contextual situation creates the three structures:

- Multiplication
- Partitive Division
- Measurement Division

1.33 Multiplication and Division Types and Structures

Before continuing with this segment, take a moment to download and print the Multiplication and Division Problem Types and Structures chart. It can be found by clicking on Resources in the top, right corner of the screen.

1.33 Structures of Multiplication and Division

A multiplication situation is one in which the number of items per group and number of groups are known. The goal is to find the total, or product.

A partitive division situation is one in which the total number of items and the number of items per group are known. The goal is to find the number of groups.

A measurement division situation is one in which the total number of items and the number of groups are known. The goal is to find the number of items per group.

These three structures are explained in detail in the lessons and teacher instructional videos for Grades 3-4. Feel free to review those resources for more specific information and examples.

1.34 Contextual situations

Read through the contextual situations provided for each structure within this problem type.

1.35 Solution Strategies for solving problems

As with Addition and Subtraction, students may not solve these problems using the number sentence shown in the chart, or the number sentence that represents what is happening in the story.

There are several solution strategies that a student may use when solving multiplication and division situations.

In the Project SMART program, the students in your grade bands will be shown most of the strategies, and are always encouraged and expected to use the strategy that makes sense for them. The goal is for the students to move to the more efficient strategies when they are ready to do so.

1.36 Multiplicative Comparison

The Grouping and Partitioning problems discussed have involved three distinct quantities: the number of groups, the number of objects in each group, and the total.

The second problem type, multiplicative comparison, does not involve these three quantities. Instead, it involves the comparison of two quantities, in which one is described as a multiple of the other. Let's look at an example:

- The giraffe in the zoo is 3 times as tall as the kangaroo. The kangaroo is 6 feet tall. How tall is the giraffe?

Students have to understand the meaning of specific phrases such as "3 times as tall", "3 times as much", "6 times heavier" or "how many times as tall", in order to make sense of the problem.

This giraffe and kangaroo problem can be classified as a "multiplication, product unknown" problem on the structures chart.

1.37 Visualizing the Problem

Here's a visual for the problem. The problem says "the giraffe in the zoo is three times as tall as the kangaroo. The giraffe's height will be the "product unknown" in this problem. The problem continues: "the kangaroo is 6 feet tall."

This quantity represents the amount in each set, or group. In this case, each kangaroo represents a set of 6 feet. The last part of the problem says "how tall is the giraffe?"

Looking at our picture, we can tell that what is really meant by this question is "how many kangaroos does it take to equal the height of the giraffe?", or "how many sets" are needed.
If we go back to the beginning of the problem, we see that it said our total, the giraffe, is "3 times" the height of the kangaroo.

Well this means we need 3 sets of kangaroo heights, or 3 groups of 6. So we know the number of sets, or number of kangaroos, and we know how big each group is, or the kangaroo height. What we are looking for is the product, or total, or in the context of the story, the height of the giraffe. This structure is very similar to the grouping and partitioning structure called Multiplication, except the student must be able to interpret what "3 times as tall" means and picture this story a little differently.

1.38 Partitive Division Example

Let's look at an example of partitive division for this problem type.

A multiplicative comparison problem that has a partitive structure means the set size is unknown.

Read through the contextual situation and click next when you're ready to move on.

1.39 Visualizing Partitive Division

In this situation, the giraffe is a total of 18 feet tall.

The giraffe is 3 times as tall as the kangaroo. This means there are three ‟groups" of a set to put together that equal the height of the giraffe.

In the context of the story, the three sets are three ‟kangaroos", which equal the height of the giraffe. The size of the set, or the size of the kangaroo, is unknown.

This situation is very similar to the partitive division problem for grouping and partitioning, but once again, the students need to be able to interpret what ‟3 times as tall" means and be able to picture the situation in order to determine a solution strategy and solve it.

1.40 Measurement Division Example

The last structure for this problem type is measurement division.

A multiplicative comparison problem that has a measurement structure means the multiplier, or number of sets, is unknown.

Read through the contextual situation and click next when you're ready to move on.

1.41 Visualizing Measurement Division

In this situation, the giraffe is a total of 18 feet tall.

The kangaroo is six feet tall, which is the size of one set in the story.

The next part of the story says ‟the giraffe is how many times as tall as the kangaroo". This means the unknown is the number of kangaroos, or the number of sets, it takes to equal the height of the giraffe. So the total is known, the number in each set is known, but the number of sets is unknown.

Once again, this structure is very similar to the grouping and partitioning structure for measurement division, but the students must be able to interpret the part of the story that says ‟the giraffe is how many times as tall as the kangaroo" and be able to determine a solution strategy for the problem.

1.42 Conclusion for Multiplication and Division Problem Types

Because the structures for Multiplicative Comparison problems are so similar to grouping and partitioning problems, it is imperative that students have many opportunities to develop a solid understanding of those problems before moving into multiplicative comparison problems. Which is why in Project SMART, the Multiplicative Comparison problems are only included in the CGI activity for grades 5-8.

This concludes the overview for Multiplication and Division problem types in CGI. It is time for the end of course quiz.