

High School Mathematics Lesson Plan: Algebra

Each lesson in the Adolescent Literacy Toolkit is designed to support students through the reading/learning process by providing instruction before, during, and after reading/learning.

Note that lessons incorporate the *gradual release of responsibility* model. When this model is used within a single lesson and over several lessons, students are provided with enough instruction and guidance to use the literacy strategies on their own. The following lesson includes some examples of explicit instruction and modeling, guided practice, and independent practice, but students need more practice and feedback than is possible within the context of a single lesson.

Bold print indicates a direct link to the *Content Area Literacy Guide* where readers will find descriptions of literacy strategies, step-by-step directions for how to use each strategy, and quadrant charts illustrating applications across the four core content disciplines.

The following lesson plan and lesson narrative show mathematics teachers how they can incorporate the use of literacy strategies to support high school students to learn mathematics content and concepts. The lesson is designed for a one block period (80–90 minutes) or two traditional classes (50 minutes).

Instructional Outcomes

NCTM Standards: 10.1 Analyze patterns, relations, and functions of one and two variables.
1.4 Monitor and reflect on the process of mathematical problem solving.

Content Learning Outcome: Students will learn how to think about and connect mathematics text, examples, and exercises to determine when to use algebraic solutions to solve systems of equations.

Literacy Support Strategies and Instruction

Before reading/learning: **Think-Aloud** (teacher modeling)

- Materials: Sample of a real-life problem that demonstrates how elimination, addition, or subtraction can be used to solve a system of equations (see clothing sale example below)

During reading/learning: **Think-Aloud** (whole group guided practice)

- Materials: Text selection for using elimination, addition, or subtraction to solve a system of equations, and a prepared **Think-Aloud** on how to solve the system of equations (see sample below)

After reading/learning: **Think-Aloud** (individual/paired group practice)

- Materials: Text selection with explanation and examples of how to solve the system of equations by substitution, addition, or subtraction

Before Reading/Learning (10 minutes)

Literacy outcome: Students will learn that metacognition, “thinking about thinking,” supports comprehension of the text, symbols, definitions, and problems in mathematics by seeing how

the teacher uses the **Think-Aloud** reading/learning strategy to activate metacognitive thinking.

Teacher preparation:

- 1) Select a short algebra problem that can be used to demonstrate the thinking involved in constructing an algebraic solution, such as:
In a clothing store, in a mall that rents space at \$1.50 per square foot per month, the manager is planning a sale. Normally, sweatshirts and jeans are priced and sold separately. She will bundle the clothing as a set, selling four sweatshirts and one pair of jeans for \$190, or two sweatshirts and two pairs of jeans for \$140. Assuming the prices of the clothes are fixed, what is the price of a pair of jeans?
- 2) Prepare a **Think-Aloud Planning Guide** for the problem that defines what you will say during the **Think-Aloud** to model how good readers actively engage with text and symbols as they work through the process of understanding and solving a problem. Analyze the learning task to plan the **Think-Aloud**:
 - What do I need to know how to do when reading and solving this problem?
 - Where will I pause and think aloud? Mark the problem with notes about what you'll say.Example of pause point thinking:
What am I trying to find?
What type of calculation is required?
What information do I need?

Teacher facilitation:

- 1) Introduce the **Think-Aloud** by explaining that it is a very useful strategy for monitoring thinking and learning.
- 2) Explain that you will model this thinking process using a word problem about shopping.
 - Write the problem on the board.
 - Explain to students how you thought about what was confusing in the text and how you thought of questions to ask to help you solve the problem.
- 3) After you have done the **Think-Aloud**, ask the students what questions they have about using the **Think-Aloud** strategy for “thinking about thinking” to read and solve a written word problem.

During Reading/Learning (45 minutes)

Literacy outcome: Students will experience how using a **Think-Aloud** strategy surfaces thinking and identifies solutions that help to solve word problems presented in a math textbook.

Teacher preparation (prior to class instruction time):

- 1) Prepare **Think-Aloud** notes for the initial text pages on *Algebraic Solutions to Systems of Equations* to model how to do a **Think-Aloud** when reading the math text.
 - Sample of **Think-Aloud** notes for *Solving Systems of Linear Equations and Inequalities, Lesson 7-2*. Glencoe Algebra 1 textbook (2005 edition)
http://www.glencoe.com/sec/math/algebra/algebra1/algebra1_05/extra_examples/chapter7/lesson7_2.pdf
Example 1: I'll model this entire problem to review the **Think-Aloud** process. When I pose the two equations ($2s - y = -3$ and $x = 2y$), I'll explain what happens in my head as I simplify, combine like terms, and how I check my answer by

replacing x with -2 and y with -1 .

Example 2: I'll have the students help me do the **Think-Aloud** by giving them cues. The equations are $y - x = -4$ and $6x + y = 3$. So for the first equation, I'll ask them what should be added to each side and what the simplified equation will say. For the second equation, I'll ask them to figure out how we can find the value of x and guide them to the answer, substitute $-4 + x$ for y . Then I'll ask them to determine the next step, combine like terms, and ask what can be added to each side to simplify. They should readily see that each side should be divided by 7 to simplify the equation further, resulting in $x = 1$. Then I'll see if they got the concept of substitution by asking them to solve the first equation for y .

Teacher facilitation:

- 1) Tell the class they will read through a section of the text that contains examples designed to explain how to use substitution to solve a system of equations. Tell them that using the **Think-Aloud** strategy can help them identify strategies that lead to the solution, the type of calculation required, and what information is needed.
- 2) Model the **Think-Aloud** process for students with the first example.
- 3) For the next example, ask prompting questions to help students participate in the **Think-Aloud**.
- 4) Ask students to work on the next two examples in pairs. One student in each pair should read the first problem and use the **Think-Aloud** to work through it with a partner's help. The second student should take the "lead" with the second problem. Remind students to share their explicit thinking with one another about what they are thinking as they make sense of the problem, where they have questions, etc.
- 5) Circulate to listen and ascertain that students talk about their thinking as they make sense of the word problems they are to solve using systems of equations. As necessary, prompt students to slow down and not skip steps.

After Reading/Learning (20 minutes)

Literacy outcome: Students will reflect on how their use of the **Think-Aloud** strategy affected their understanding of sections of a mathematics text and/or how to solve word problems.

Teacher facilitation:

- 1) Ask pairs to join with other pairs and share responses to the following questions written on the board:
 - How did you go about thinking through each problem or section of the text? Did both pairs use exactly the same thinking and reasoning?
 - How did the use of the **Think-Aloud** affect the way you approached solving the word problem or reading the section of the text? What was it like to listen to another person's thinking?
- 2) Ask students to continue practicing the **Think-Aloud** strategy while reading more of the chapter about solving systems of equations or while working on related word problems.

Suggested Subsequent Lessons

To provide additional practice so students are able to do **Think-Alouds** on their own, the teacher can continue to use the strategy when introducing new topics. The teacher could also follow modeling with students practicing **Think-Alouds** in pairs. The **Think-Aloud** strategy can

also be combined with other literacy strategies during teacher modeling and student practice to sustain an emphasis on metacognitive thinking. For example, **Think-Alouds** can be used to model and practice **Coding** to improve reading comprehension, or the **Frustration Model** can be used for concept development. Note: Teachers can also ask students to do **Think-Alouds** as they read a text or think through a math problem to help diagnose where a student may be making errors in their assumptions or have gaps in their understanding.

High School Mathematics Lesson Narrative: Algebra

Teachers: As you read the lesson narrative, think about the following questions. You may want to discuss them with fellow mathematics teachers.

- *What does the teacher do to support students' literacy development and content learning before, during, and after reading/learning?*
- *What challenges do you anticipate if you were to implement this lesson in your own classroom? How would you prepare to meet these challenges?*
- *How would you make improvements to this lesson?*

Ms. Bamford sighed as she pulled out her planner. Next week the students would begin studying algebraic solutions to systems of equations. She had noticed quite a few students in her 9th grade algebra classes were struggling with word problems. Studying their answers on quizzes and homework indicated that many did not appear to know how to think through a problem and figure out the calculation or steps leading to a solution. Additionally, the textbook did not clearly explain how to solve a problem. She found an article on **Think-Alouds** which explained that it is a metacognitive strategy where learners surface their thinking to make their thinking available to others. Maybe if she could explain to students what thinking happens inside her head as she approaches algebraic problems, they could try the thinking strategies she uses to solve math problems when working in groups or on their own to understand math texts.

Before Reading/Learning

"Today we're going to begin a new unit on *Algebraic Solution to Systems of Equations*. You'll be learning how to use elimination, addition, subtraction, multiplication, and division to solve systems of equations that include two or more variables. You'll need to think of ways to solve the problem and choose the best method." Several students grumbled, but Ms. Bamford continued patiently. "I'm going to help you understand how to proceed by describing what happens in my mind as I work through these kinds of problems. The strategy I'm going to use is called a **Think-Aloud**. It's used to help you focus on what thinking is going on inside your head while you're trying to understand a page in the math textbook or a word problem. Here's how it works."

Ms. Bamford projected the problem on the board: *In a clothing store in a mall that rents space at \$150 per square foot a month, the manager is planning a sale. Normally blouses and pants are priced and sold separately. She will bundle the clothing as a set, selling four sweatshirts and one pair of jeans for \$190, or two sweatshirts and two pairs of jeans for \$140. Assuming the prices of the clothes are fixed, what is the price of a pair of jeans?*

She asked, "Can anyone tell me the answer to this problem?" The entire class avoided making eye contact with her and sat silently. "When I first read it, I felt a bit confused. I saw that I didn't know how to solve it in my head and asked myself, what does the cost per square foot for the store space have to do with the clothing sale?" She paused, looking to see if the students were following her thinking so far. Some were staring at the problem on the wall, some were looking at her, and a few were writing—notes to each other, she suspected, rather than notes about the lesson. "So, Jack," she asked to draw one student's attention back to the lesson, "what do you think I decided to do next to approach this problem?" "Not sure," was the reply. "Okay, if you are not sure, what could you do?" asked Ms. Bamford. Jack said, "I guess I'd read the problem over again."

“Yes, and that’s just what I decided to do. I re-read it and thought some more and decided the first question I needed to answer was, *what am I trying to find out?* Once I have that information, I can decide how to approach the problem and take steps to solve it. Who can help me?” Andrea raised her hand, “How much do the jeans cost for just one pair?” “That’s right, Andrea. Maybe I don’t like those sweatshirts, or I already have enough sweatshirts. So what information do we need to find out the cost? Let’s read more.”

Going sentence by sentence through the problem, thinking aloud, Ms. Bamford noted the rental space information does not matter in this problem because that information doesn’t relate to the price of jeans. But the information about the two sets of clothes is needed because jeans are included in both sets. She continued writing on the board as she talked. “Here’s what I’ll do: I’ll define the price of a sweatshirt to be x and the price of a pair of jeans to be y . So what I know from the problem is that $4x + y = 190$ and $2x + 2y = 140$. Now I see why I couldn’t do it in my head. There are two variables. I think to myself, how could I get rid of, or eliminate, either x or y ? I see that if I multiply the second equation by two and minus it with the first equation, y will be left as the only variable. Here’s how that will look: $4x + 4y - (4x + y) = 280 - 190$. Simplified, I have $3y = 90$, so $y = 30$. Now I know the price of a pair of jeans is \$30.”

“So what questions do you have about the **Think-Aloud** strategy, which is ‘thinking about my thinking,’ to help understand a word problem and figure out a way to solve it?” When no one responded, she said, “Well then, let’s move on.” They’ll have lots of questions when they try to do it themselves, she thought.

During Reading/Learning

“Now it’s your turn. We’re going to solve several word problems using the **Think-Aloud** strategy. Working in pairs, each of you will solve a problem using a **Think-Aloud**. One person will read the word problem and then go back and think through it aloud. The other person will listen carefully to their thinking and work through any places where their partner gets stuck. Then the second person in the pair will take the lead on thinking aloud through the problem.” Several students stirred anxiously in their seats. “Do you feel ready to try the ‘thinking about thinking’ process on your own, or would you like to work through one more example together?” Visibly relieved, several students called out in unison, “Another one with you!”

Well, I guessed that one right, Ms. Bamford thought to herself. She had already prepared a second **Think-Aloud** example from their textbook chapter. “Okay, turn to Chapter 7: *Solving Systems of Linear Equations and Inequalities*, Lesson 7-2. Let’s read the examples together as we use the **Think-Aloud** to figure how to use substitution to solve systems of equations.” Step by step she repeated the **Think-Aloud** process with the class, leading them through one example and having them contribute during the second example.

She assigned students to work in pairs to solve the next two word problems on their own and complete a **Think-Aloud** with their partner. The students settled into the task more easily than she expected. She circulated the classroom, prompting where necessary for students to slow down and not skip steps. She listened as the students presented their **Think-Alouds** and was pleased.

After Reading/Learning

“Okay, I want each pair to find another pair and share two things:

- 1) How did you go about thinking through each problem? Did both pairs use exactly the same thinking and reasoning?

- 2) How did the use of the **Think-Aloud** affect the way you approached solving the word problem? What was it like to listen to another person's thinking?"

Ms. Bamford wrote these questions on the board as students moved into groups of four.

Although several students stumbled through their explanations, she could hear in their discussions that asking what, how, and why had helped them focus on what thinking the problem required. Most of the pairs had figured out the correct answer to both problems and where a different answer had been reached, sharing the thinking in the group of four resolved the issue.

"Okay, good work with this. We can use this strategy to think through some of the more dense sections in the math textbook, too, not just with word problems. We can try that when we start the next chapter. See if you can use the **Think-Aloud** strategy tonight as you work the four problems on page 67."

As the class ended she thought, maybe I'll try some **Coding** during the next lessons. That's very much like a **Think-Aloud** except they'll be thinking on paper. They could use sticky notes with short codes instead of talking about the thinking that goes on inside their heads. I think if I use both strategies several more times it will help students get better at "thinking about their thinking." Hopefully that will strengthen their confidence and ability to read and solve written problems and read sections of the text.