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Lesson in Action

AT A GLANCE

Launch

- Introduce the mathematical content and strategy goals for the lesson.
- Model the thinking aloud process for students before groups start working.

Learning Task

- Have students work in pairs.
- Remind students to be supportive listeners.
- Circulate around the room as pairs work, providing prompts and feedback as needed.
- After all pairs have worked on two rules, bring the class back together for discussion.
- Give students a handout with tables based on pairs of sequences.
- Divide students into groups of three or four and give each group a different table to work on.
- Circulate around the room as pairs work, providing prompts and feedback as needed.

Closure

- Bring the class back together for a final discussion.
- Ask students to share how thinking aloud can help them in the future.
- Have all students write a paragraph about what they liked and disliked.

Thinking Aloud: Number Crunching

Context

School started last week and Mrs. Jefferson is busy figuring out where her Grade 5 students are in terms of their mathematical understanding. They know their addition and subtraction facts, and most remember their multiplication facts. As expected, students are reluctant to describe aloud the steps they follow to find an answer. When she asks them to explain the steps in their work, her students say they don't know or just look at her, clearly unsure what to say.

Common Core State Standards

- ▶ [CCSS.Math.5.OA.3](http://www.corestandards.org/Math/Content/5/OA/B/3) (<http://www.corestandards.org/Math/Content/5/OA/B/3>) Generate two numerical patterns using two given rules. Identify apparent relationships between corresponding terms. Form ordered pairs consisting of corresponding terms from the two patterns, and graph the ordered pairs on a coordinate plane.
- ▶ [CCSS.Math.MP2](http://www.corestandards.org/Math/Practice/MP2) (<http://www.corestandards.org/Math/Practice/MP2>) Reasoning abstractly and quantitatively.

Lesson Objective

Students will begin practicing the thinking aloud strategy so that they can effectively employ this strategy as they move forward and learn the mathematical language necessary to communicate their thinking.

Technology

- ▶ Interactive whiteboard to communicate visually with the class
- ▶ Classroom response system to collect anonymous feedback from students
- ▶ [Whole Number Cruncher](http://www.shodor.org/interactivate/activities/WholeNumberCruncher/) (<http://www.shodor.org/interactivate/activities/WholeNumberCruncher/>) applet to provide numerical patterns for students to use

Assessment

- ▶ Observe students' use of the thinking aloud strategy
- ▶ Elicit comments from students about the learning task
- ▶ Assess formatively throughout, using individual whiteboards
- ▶ Read students' critiques of the strategy

Mrs. Jefferson's Class in Action

Launch

Mrs. Jefferson displays the Whole Number Cruncher applet on the interactive whiteboard.



Can you figure out the rule?

“For today’s lesson you need to figure out how this machine creates an output number from an input number. I want you to try thinking aloud as you work with a partner on these problems. The way you’re thinking about a problem is just as important as getting the correct answer. We’ll do a problem together first where I do the thinking aloud, then one of you will lead us on a second problem.”

She points to the applet and says, “I choose 1 for my first number because it’s small and easy to calculate with.” She enters 1 and the machine outputs 8.



“I wonder what the machine is doing,” she ponders out loud. “The machine only adds and multiplies. It could be multiplying by 8 or adding 7. I don’t have enough information to figure out the rule, so I’m going to try another number.”

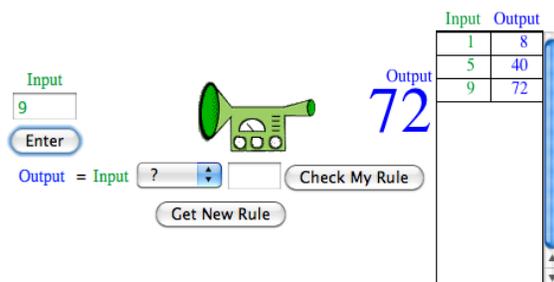
Mrs. Jefferson enters 5 for the input and the machine outputs 40. She continues thinking aloud, “At first I thought it might be multiplying by 8 or adding 7. This time, it turned 5 into 40.”



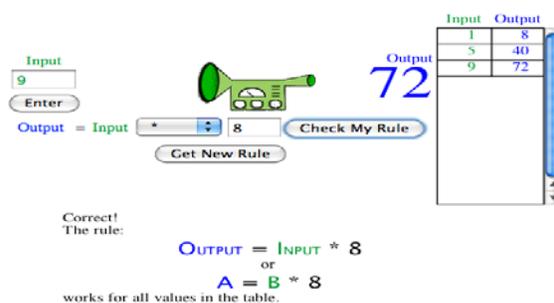
Pointing to the 5, she asks, “If it were adding 7, what would the output be?” Jimmy, who rarely volunteers, offers the answer “12.”

“Does everyone agree?” Mrs. Jefferson asks. “Use your clickers,” she says, referring to the classroom response system. When all of the students have responded, she puts the results on the whiteboard. “Everyone agreed,” she observes.

“The output isn’t 12,” Mrs. Jefferson tells the class, “so the machine can’t be adding 7. Did it multiply by 8?” She calls on another student and checks that everyone agrees the product is 40. “I’m going to try one more input and predict the answer, to make sure that my rule is correct. If I use 9 as the input, then the output should be 9 times 8, which is 72.”



She enters 9 as the input and smiles when the output is 72. She enters the rule and checks that it is correct.



Carly volunteers to come up and demonstrate thinking aloud. Mrs. Jefferson prompts her to talk about her reasoning, reminding students that they can ask their partners for clarification.

Learning Task

Mrs. Jefferson directs students to work in pairs. One partner works on the applet and thinks aloud while the other listens. They then switch roles for a new rule.

“If you are listening, you can ask questions or make suggestions,” Mrs. Jefferson reminds the class. “Don’t just tell your partner the answer.” She passes out a handout with sentence starters, “You can use these starters if you’re not sure what to say next.”

As students work, Mrs. Jefferson circulates around the room and listens to conversations, reminding some students to think aloud.

Billy is looking at a table filled with several numbers. “If I go up another 1,” he says, “it’ll add another 3 because all the outputs are going up by 3.” Megan says, “Sure, but you need to figure out what it does to the input to get the output. Maybe you should try a big number like 100.”

“Good suggestion,” Mrs. Jefferson says, moving on to another pair.

Taylor is thinking aloud, “I’m going to try 5.” When the machine outputs 10, he says, “I’ll try 15 next.” Aliyah doesn’t say anything, so Mrs. Jefferson breaks in. “Talk about your

thinking, Taylor,” she suggests, “and can you tell me why you decided to try 15?” Taylor shrugs and says, “I saw 5, then 10, so I just went to 15.”

“OK, good,” Mrs. Jefferson says. “It didn’t matter so much why you picked that number, but that Aliyah heard your reasoning. Aliyah, remember that you can help by asking Taylor to explain his reasons if you don’t understand them. What’s next?” Taylor enters 10. The output is 20, which causes him to think about multiplying by 5. “Wait a minute,” he groans, “that’s not right, is it? Because 5 gave me 10?” He looks at Aliyah, who says, “Try it and see!” Mrs. Jefferson nods and walks away.

When all the students have done at least two rules, Mrs. Jefferson asks them to return to their desks and share observations. Megan says, “When Billy added 1 to each input, the output went up by 3, and the rule was to multiply by 3. Does it always work that way?” Mrs. Jefferson replies, “That’s a good question. As it happens, we’re going to look at some examples like that!”

She passes out a handout with tables to fill out based on pairs of sequences, like this example:

Input	Output
Add 1	Add 4
0	0
1	4

She instructs students to write the next input and output for the example on their whiteboards to verify that they all understand what to do with the tables. She then uses the example to model how she wants students to think aloud for this activity.

Mrs. Jefferson divides the students into groups and assigns each one a different table on the handout. She instructs them, “Continue the sequences using the given rule, checking with your group to be sure everyone has the right numbers. Then, work together to find the rule to get the output from the input. Finally, figure out why the rule makes sense from the sequence directions.”

While students work, Mrs. Jefferson circulates around the room listening to their conversations and encouraging them to explain clearly. She notes students who are having difficulty articulating their thinking.

Closure

Mrs. Jefferson has a student from each group explain how his or her group decided on the rule and why it made sense. She encourages presenters to ask group members for help if they have difficulty with their explanations.

She asks students to share what they found helpful about thinking aloud. For the exit ticket, students write a paragraph about what they liked and didn’t like about the strategy.

Reflection

Mrs. Jefferson noted that most students were able to find a relationship between two sequences, but several were unable to articulate their reasoning without prompting. She expects students will do better as they begin to learn the language they need to communicate their thinking. As she reads through the exit tickets, she is not surprised that the students who had difficulty articulating their reasoning have said the most negative things about thinking aloud. However, she is glad to see that many students are able to say something positive. Noting the positive comments along with her reflections, she will bring them up the next time she directs students to use the thinking aloud strategy.