

Disciplinary-Based Formative Assessment

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Overview

- Formative assessment/lesson planning
- Disciplinary knowledge for formative assessment
 - ☐ Mathematics
 - ☐ Science
 - ☐ English language arts (writing and reading)
 - ☐ Social studies
- Summary

Formative Assessment

Formative assessment is a range of practices that encourage both teachers and learners to seek evidence of the ways in which students are developing their knowledge, skills and understanding with the intention of using the evidence to inform ongoing learning.

Formative assessment requires a dynamic approach to assessing learning with assessment opportunities embedded into the ongoing learning activities and interactions in the classroom.

Evidence of learning for both teacher and student use is generated from these classroom activities, is explored, and then acted upon during the learning.

(Harrison & Heritage, in press).

Disciplinary Knowledge: Evidence

- Situations, activities, tasks, or questions that generate observable evidence (know what constitutes evidence)
- Evidentiary reasoning presumes grounding in disciplinary content

Bennett, 2019

Formative Assessment Practices



- 1 Clear learning goals & success criteria
- 2 Eliciting and interpreting evidence of learning while it is developing
- 3 Immediate or near-immediate evidence-based responses
- 4 Feedback to students
- 5 Student involvement – peer feedback and self-assessment

Lesson Planning

| | |
|---|------------------|
| Standards | |
| Learning Goal | Success Criteria |
| Tasks/activities/strategies to help students meet the learning goal | |
| Formative opportunities in tasks/activities/strategies to gather evidence of student learning | |
| Questions to gather evidence of student learning | |

Lesson Planning

| Standards | |
|---|--|
| Learning Goal | Success Criteria |
| Tasks/activities/strategies to help students meet the learning goal | <ul style="list-style-type: none">• Interpret the evidence• Decide what action to take• Feedback |
| Formative opportunities in tasks/activities/strategies to gather evidence of student learning | |
| Questions to gather evidence of student learning | |

Disciplinary Knowledge for Formative Assessment

Knowledge for Teaching (and formative assessment)



“...the special amalgam
between content and
pedagogy.”

Shulman, 1987, p. 7

Mathematics

[Mathematics teachers] face the dual challenge of opening up their pedagogical practices *and* learning to incorporate evidence of student thinking into dynamically evolving lessons.

Burkhardt & Schoenfeld, 2019, p.36

Mathematics

Tasks student tackle must include a substantial proportion of **non-routine problems** that ask students to **represent information, make practical estimates, review and critique arguments, evaluate and recommend options, design, plan, and define concepts**, as well as show **reliable fluency** in technical exercises. This kind of balanced diet, which integrates mathematical concepts and practices, remains rare in classrooms.

Burkhardt & Schoenfeld, 2019, p.37

Mixing Drinks

When Sam and his friends get together, Sam makes a fizzy orange drink by mixing orange juice with soda.

On Friday, Sam makes 7 liters of fizzy orange by mixing 3 liters of orange juice with 4 liters of soda.

On Saturday, Sam makes 9 liters of fizzy orange by mixing 4 liters of orange juice with 5 liters of soda.



1. Does the fizzy orange on Saturday taste the same as Friday's fizzy orange, or different?

If you think it tastes the same, explain how you can tell.

If you think it tastes different, does it taste more or less orangey? Explain how you know.

Question 2

On Sunday, Sam wants to make 5 liters of fizzy orange that tastes *slightly* less orangey than Friday's and Saturday's fizzy orange. For every liter of orange, how many liters of soda should be added to the mixture? Explain your reasoning.

Reasons additively rather than multiplicatively

For example: The student states that the fizzy orange tastes the same on Saturday as it did on Friday because one more liter of orange and one more liter of soda has been added and these just 'cancel each other out' (Q1).

Or: The student states that the fizzy orange tastes the same on Saturday as it did on Friday because both mixtures contain one more liter of soda than orange (Q1).

- How could you use math to check that the addition of a liter of orange and a liter of soda has no effect on the taste?
- What would happen to the taste if a liter of orange and a liter of soda were added to 1 liter of soda?
- If 3 liters of fizzy orange was made in the same way, by mixing 1 liter of orange with 2 liters of soda, would this taste the same also?

Sole focus on soda as the diluting ingredient

For example: The student thinks that Saturday's fizzy orange will taste less orangey than Friday's, because it has more soda in it than Friday's has (Q1).

- How much orange is in Saturday's fizzy orange? How much orange is in Friday's fizzy orange? What do you notice?
- If 5 liters of fizzy orange were made by mixing 4 liters of soda with 1 liter of orange, would it also taste more orangey than Saturday's fizzy orange?

Responding to Evidence

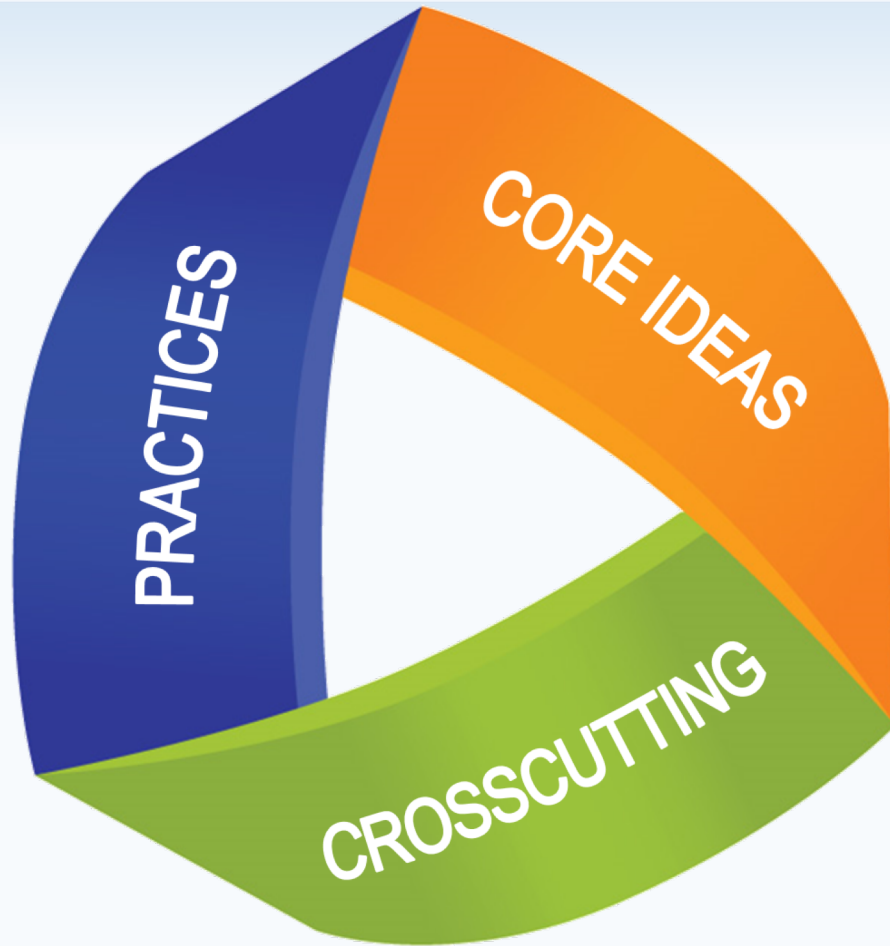
- Write one or two questions on each student's work, or
- Give each student a printed version of your list of questions, and highlight the questions for each individual student, or
- Select a few questions that will be of help to the majority of students and write these questions on the board when you return the work to the students in the follow-up lesson.

Science

Science, as a discipline, encompasses both the **body of knowledge** which represents the current state of understanding of the natural world, as well as the **processes and practices** by which that body of knowledge is continuously built, refined, and extended.

National Research Council, 2007

NGSS 3 Dimensional Learning



- Integration of content strands with disciplinary practices
- Application of core ideas to explaining phenomena in the world
- Solving problems using the kinds of practices that disciplinary experts use

Learning Goals are 3-Dimensional

Learning goal: Understand how the structure of DNA relates to its function

Built from the following three dimensions.

DCI (LS1.A, 9-12): Structure and function -DNA is a warehouse of the genetic code that provides information that controls cellular structure and activities

SEP: Developing and using models- modeling how DNA is transcribed into RNA: how RNA is translated into polypeptide protein; make models to describe the function of DNA

CCC: Structure and function- the way in which an object or living thing is shaped and its substructure determines its properties and functions

Success Criteria

- Describe the structure of DNA
- Explain why the base pair rule means DNA forms complementary strands and a double helix
- Demonstrate the processes of transcription and translation
- Use a DNA sequence (structure) to construct a polypeptide/protein (function)
- Explain how a mutation (change in DNA base sequence may, or may not, alter the function of a protein

Interpreting Explanations of Horizontal Motion

Highly-skilled interpretation by teachers:

- Noted that the inexperienced physics students typically expressed speed as proportional to the net force acting on the object
- When object was speeding up the net force was getting larger and larger
- When the object was moving with constant velocity the net force was constant
- Pointed out that students were likely correctly distinguishing between constant speed and speeding up

Interpreting Explanations of Horizontal Motion

Lower-skilled interpretation by teachers:

- Tended only to note that the students were wrong about the net force needed
- Recited the correct relation between force and motion

Writing

...teachers envision what to teach next as they assess and confer with their writers. Gladwell (2007) explains that it is a mark of expertise to be able to make judgments in the blink of an eye. The reverse is also true: making judgments quickly is not easy for people whose expertise lies elsewhere. If teachers are new to the teaching of writing, it can be challenging to look at a student's text and to know the traits worth noting. The ability to grasp what a writer is trying to do and to see how to help the writer do that work better (or to tackle something else that is even more important) represents the epitome of effective writing instruction.

ELA: Writing

- *Which words are too vague that I need go back and strengthen to better support the content of my essay?”*
- *“What transitions can I incorporate to strengthen the coherence of my essay?”*



Source: Julie Eilersten, Hamilton High School

Well-Written Argument Essays

- What other evidence can I utilize to support my claim?
- What other background or context do I need to provide to orient my reader to the text?
- How can I develop my analysis/commentary
- Where am I best synthesizing and connecting sources to my claims?
- What is my position and how does my evidence support or not support it?
- What do you see as my main argument and what are my main claims to support that?
- What clarification do I need in my argument?
- What other ways can I introduce or weave in my evidence to help create flow/ coherence?

Reading

*...the **close, attentive reading** that is at the heart of understanding and enjoying complex works of literature...seek the **wide, deep, and thoughtful engagement** with high-quality literary and informational texts that **builds knowledge, enlarges experience, and broadens worldviews**...[and]reflexively demonstrate the **cogent reasoning and use of evidence**.*

(ELA CCSS, 2010, p. 3)

Social Studies

Now more than ever, students need the intellectual power to recognize societal problems; ask good questions and develop robust investigations into them; consider possible solutions and consequences; separate evidence-based claims from parochial opinions; and communicate and act upon what they learn. And most importantly, they must possess the capability and commitment to repeat that process as long as is necessary. Young people need strong tools for, and methods of, clear and disciplined thinking in order to traverse successfully the worlds of college, career, and civic life.

C3 Framework: Inquiry Arc

- Developing questions and planning inquiries
- Applying disciplinary concepts and tools
- Evaluating sources and using evidence
- Communication conclusions and taking informed action

Can we be both free and safe?

Complexity of the decisions Franklin D. Roosevelt made as the nation's leader in the wake of Pearl Harbor

Attention Students! There is a virus in this room. You can keep the virus in our room and it will kill us all. Or, you can release the virus from our room, save yourselves but wipe out the entire population of the school. Which do you choose? You have 5 minutes to deliberate on which decision your group will make?"

Guiding Questions

- What did you decide?
- What led you to that decision (what was your rationale)?
- What did your group value in making your decision?
- How strongly, on a scale of 1-10, do you feel that you made the right decision?
- You open the newspaper tomorrow, how do you think your decision will be seen by the rest of the world?

- Executive Order 9066: *“What rationale was given by the government when the executive order was issued?”*
- First-hand account by internee, Aiko Herzig-Yoshinaga: *How did Japanese-Americans experience internment?*
- Probing questions relating to disciplinary practices:
 - *What information does one source have that the other doesn’t?*
 - *Are the two sources corroborative? How?*
 - *What are the strengths and limitations of these two sources?*

Homework Assignment

- Where to site a recycling center in their town



Disciplinary-Based Feedback – Social Studies

- *You have clearly evaluated how the public can access the site and how it can be made to blend in with the surroundings. Think a bit more about the likely quantity of recycling for a town of this size and capacity on site.*
- *Good idea to signpost routes to the site. Which factors may limit the size of the site and how will overuse be dealt with?*
- *Clear representation of the site and thoughts about capacity. How are you going to persuade nearby shops that this is the best site?*

Disciplinary-Based Feedback – Social Studies

- *You have clearly evaluated how the public can access the site and how it can be made more accessible. Think a bit more about the likelihood of this size and capacity on site.*
- *Good idea to signpost the size of the site and the number of visitors may limit the size of the site.*
- *Clear representation of the site's capacity. How are you going to perform the best site?*

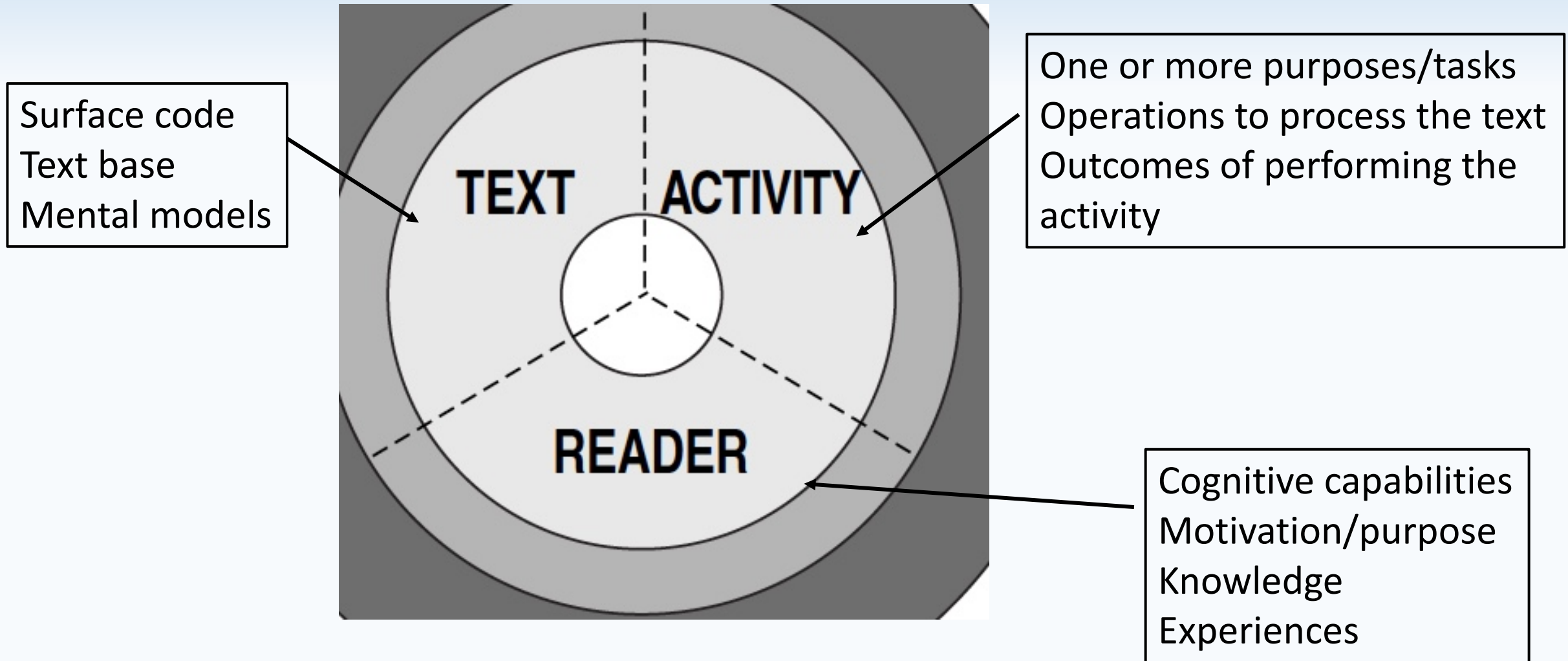
At the beginning of the lesson worked in pairs using feedback to improve their work.

Summary

- Disciplines have their own ways of knowing and doing
- Content knowledge for teaching and content pedagogical knowledge are essential
- Formative assessment practice rooted in the disciplines

Thank you!

ELA: Reading



Source: RAND, 2002

First-Grade Class

- Previous lesson teacher had observed students unsure about equal sign as symbol of equality
- Plans lesson with the goal of helping her students understand more clearly that the equal sign indicates that quantities or expressions “have the same value”

First-Grade Class

- Solve problem individually $8 + 4 = \square + 7$.
- Observes how they are solving the problem, makes notes about the different solutions and strategies the students are using, and probes some of the students' thinking to learn more about their reasoning

First-Grade Class

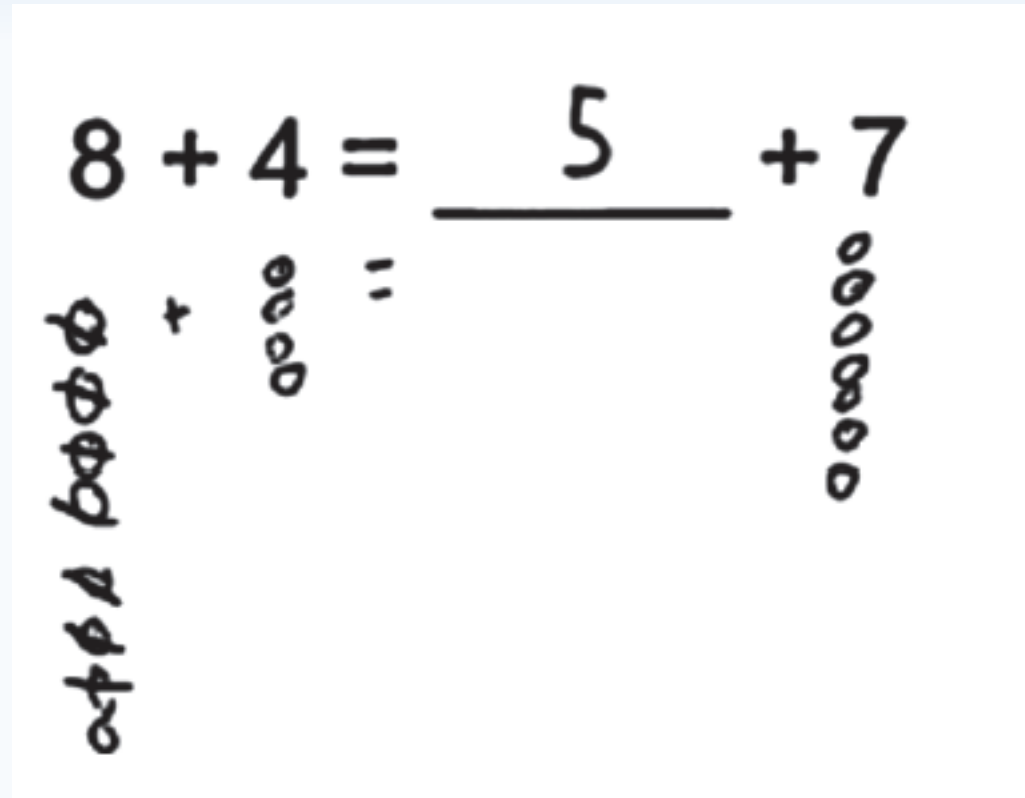
- Notices several different answers, including 12, 5, 19, 11, and 6
- Asks the students to find someone in the class with an answer that is different from their own to compare and discuss their solutions
- Listens in to their discussion, noting that some students change their answers as a result of their conversations

First-Grade Class (*NCTM, 2014*)

$$8 + 4 = \underline{12} + 7$$

○○○○○○○○ ○+○○○○

First-Grade Class (*NCTM, 2014*)



A handwritten math problem on a white background. The equation is $8 + 4 = \underline{5} + 7$. Below the number 8 is a vertical column of 8 small circles. Below the number 4 is a vertical column of 4 small circles. Below the number 7 is a vertical column of 7 small circles. The number 5 is underlined. The entire problem is written in a casual, handwritten style.

First-Grade Class (*NCTM, 2014*)

- The equal sign means that _____ .
- Students find partners to review their work, and they make revisions based on their partners' feedback.
- Collects the students' work so she can do further analysis and determine the next steps in teaching and learning.