Formative Assessment for Learning in a Precalculus Class: Helping Students Develop a Growth Mindset

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Overview of my presentation

* Background information
* Assessment _for_ learning vs. assessment _of_ learning
* The purposes and benefits of formative assessment
* Formative assessment strategies
* Using assessment to develop student growth mindsets
* Examples of things that have worked for me

Background Information

* I teach in the Department of Mathematical Sciences at Appalachian State University.

* We offer several freshman-level classes. Precalculus is one of those, but is taken primarily by students not yet ready for Calculus I.

* Class size is around 35 students and we meet 4 times a week for 50 minutes.

* In addition to the math content, I try to help my students learn how to learn.

* I try to incorporate a lot of formative assessment to help with this.

Assessment *for* Learning vs. Assessment *of* Learning

In basic terms, we are looking at *assessment* versus *grading.*

"Students need feedback and lots of it, but grades are not the best forms of feedback,"
(Wormelli, 2006, p.100)

In order to assess our students, we should be asking:

"What is it I want my students to learn?" and
"What progress have they made in getting there?"

Assessment for learning is a way to answer these questions.

Purposes and Benefits of Formative Assessment

"In A4L [assessment for learning], students become knowledgeable about what they know, what they need to know, and ways to close the gap between the two."
(Boaler, 2016, p. 149).

Purposes and Benefits of Formative Assessment

- Assessment for learning is an essential part of an iterative instructional cycle. Instructional planning is an iterative loop, not a one-way street.

- It helps you gain insight into how your students are progressing but it also provides ways for the students to *self-assess* their progress.

- Good communication is key. Students are less anxious and fearful of assessments when they understand the purpose AND when they are made part of the process.

Purposes and Benefits of Formative Assessment: Using Assessment to Guide Instruction

* In my experience, good formative assessment helps me use instructional time more efficiently.

* I try to go for deeper understanding over surface level. Assessment helps me gauge this.

* It helps me know where my students are so I know where to meet them and to know when to circle back to pick up those who have gotten lost along the way.

* I like to use a variety of assessments in order to determine if the students have integrated the concepts or if they are merely "parroting" back the right things.

Formative Assessment Strategies

* Homework
* Quizzes
* Exit Tickets
* Entry Tickets
* Think-pair-share

* Whiteboards
* Clickers
* Turn and talk
* Draw a picture
* FactStorming

…and hundreds of others. There are pros and cons of each. It is helpful to have different options to choose from. Later in my talk, I will show how I use some of these in my Precalculus class.

Resources for finding some specific strategies:

There are lots of other online sources, but these are some that I like.

* "25 Quick Formative Assessments for a Differentiated Classroom" by Judith Dodge (sample available for free at http://store.scholastic.com/content/stores/media/products/samples/21/9780545087421.pdf)

* edWeb.net "Assessment for Learning Community" at http://www.edweb.net/assessment

* "Tools for Formative Assessment" http://www.levy.k12.fl.us/instruction/Instructional_Tools/60FormativeAssessment.pdf

* "56 Examples of Formative Assessment" at http://www.edutopia.org/groups/assessment/250941

Background information on Growth Mindset

* Carol Dweck is credited with developing the concept of "Mindset" in her 2006 book *Mindset: The New Psychology of Success*.

* She discusses growth mindsets and fixed mindsets

* People with a fixed mindset, believe their basic qualities, like intelligence, are fixed traits. You either have it or you don't. Talent and innate ability create success; not effort.

* On the other hand, people with growth mindsets believe that abilities can be developed through effort. Dedication and hard work are the keys to success. You can work to become better at something.

Believe that talents can be developed and great abilities can be built over time.

View mistakes as an opportunity to develop

Growth Mind-Set

Resilient

Believe that effort creates success

Think about how they learn

Where do you think your students fall?

Believe that talent alone creates success

Reluctant to take on challenges

Prefer to stay in their comfort zone

Are fearful of making mistakes

Fixed Mind-Set

Think it is important to 'look' smart in front of others

Believe that talents and abilities are set in stone, you either have them or you don't.

Mathematical Mindset

* Jo Boaler has expanded on Carol Dweck's work in her 2016 book, *Mathematical Mindsets: Unleashing Students' Potential Through Creative Math, Inspiring Messages and Innovative Teaching.*

* In this book, Dr. Boaler explains the power of mistakes in math class and how we should help students learn to embrace those mistakes in order to learn from them.

* Helping students understand the purpose of formative assessment and helping them learn how to learn from feedback will help put them on the path to developing growth mindsets.

Mathematical Mindset

* Dr. Boaler also discusses how grades can have a negative impact on mindset.

* Students tend to focus on the grade and not on what could be done differently next time. This reinforces the fixed mindset.

* They see themselves as "A" students or "D" students, rather than looking for ways to improve and grow.

* She encourages the use of ungraded assessments for this very reason.

What I do in my classes

* I wanted to find a way for my students to become more independent learners and to take responsibility for their own learning.

* I saw a great benefit in helping them develop growth mindsets. My path to that was in my use of formative assessments.

* Today, I will talk about my use of "Plickers" and exit tickets.

"Plickers"
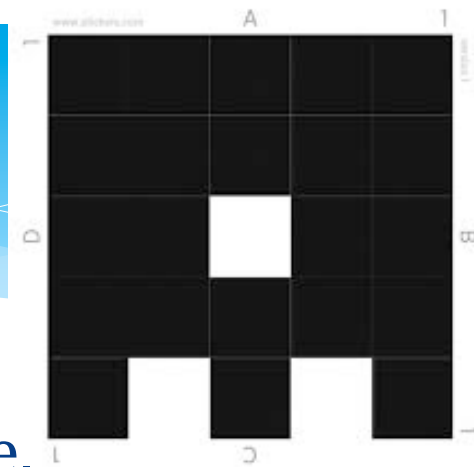
Used for in-class formative assessment.

Like "clickers" but without the electronic device.

What you need:

* Go to www.plickers.com

* A smart phone (with a working camera) for the app.

* A good printer and card stock for the cards.

* A classroom computer/projector with internet access, and the phone has to be online, if you want to use "LiveView".

Note: The app is free and the PDF for the cards is free. You can buy pre-printed, pre-laminated cards from Amazon (my personal choice).

Let's try it out…

You will notice your card has a number on it and the letters A, B, C, and D.

Use your card to indicate your response to the following questions.

If you choose "A", orient the card so that the "A" is at the top. If you choose "B", turn the card so the "B" is at the top, etc.
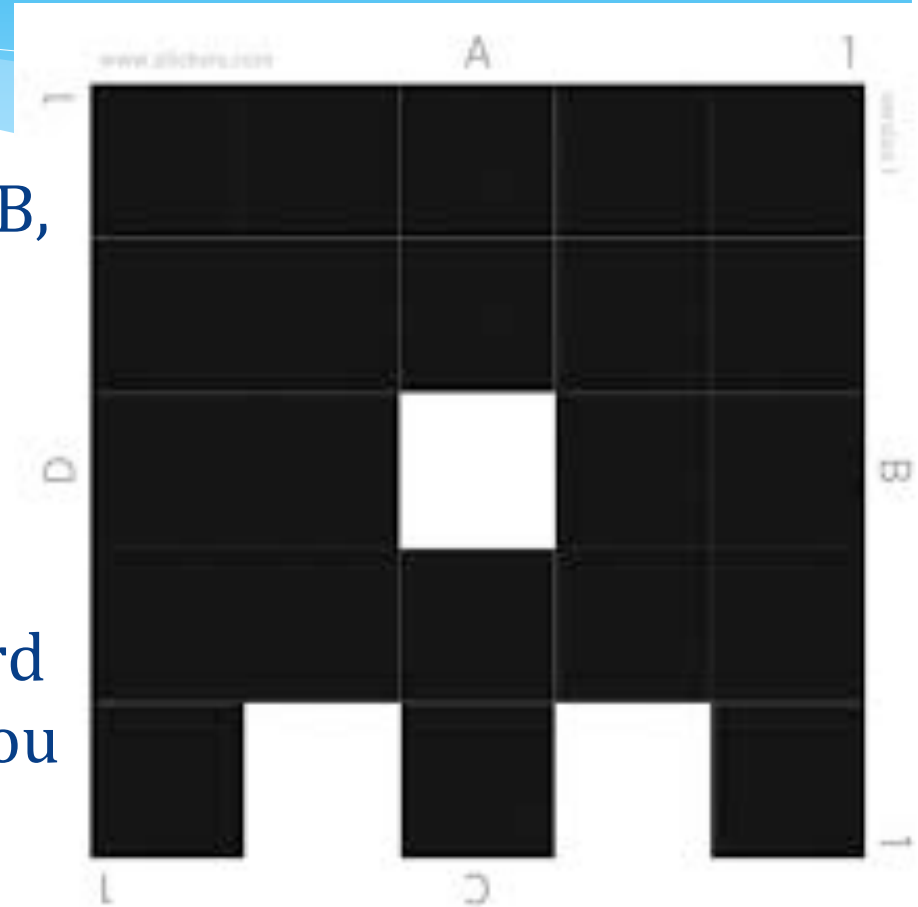
Question 1

I am currently teaching math in a high school.

A. True

B. False

Question 2

I am currently teaching Precalculus

A. True
B. False

Question 3

Formative Assessment is important for teachers to do because...

A. It helps the students know how they are doing.

B. It helps the teacher pace the lessons.

C. It helps the students develop growth mindsets.

D. All of the above.

Question 4

The graph of some function, $f(x)$, contains the point (3, -4). Which of the following points MUST be on the graph of $f(x)+5$?

A. (3, -4)

B. (8, -4)

C. (3, -9)

D. (3, 1)

Question 5

Use Figure 2.7 on the interval $-3 < x < 0$ to state whether the graph on that interval is:

A.   Concave up

B.   Concave down

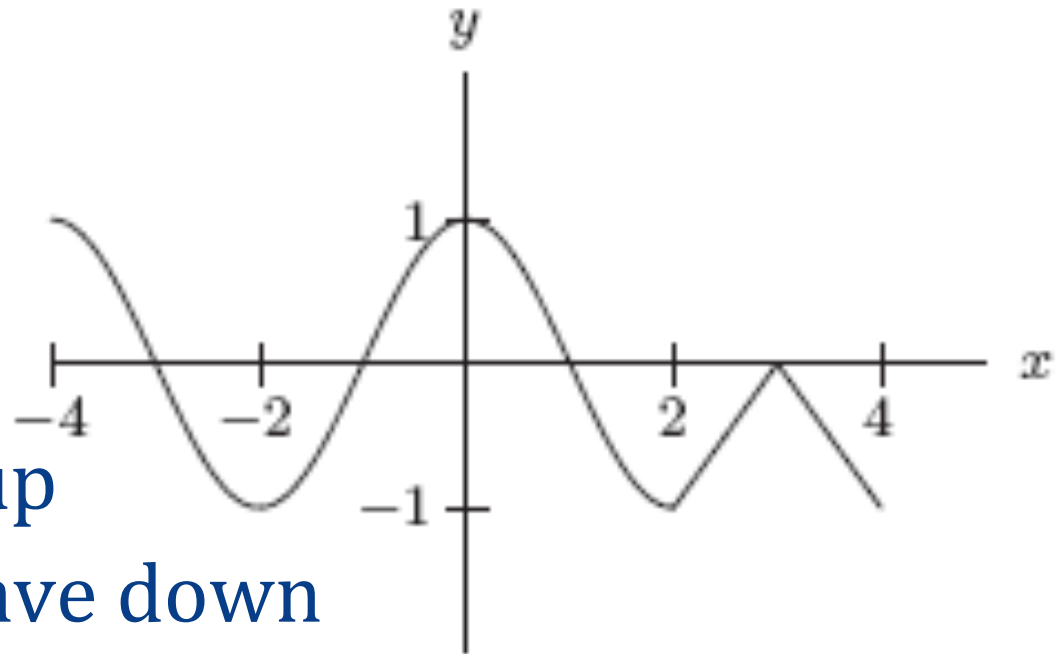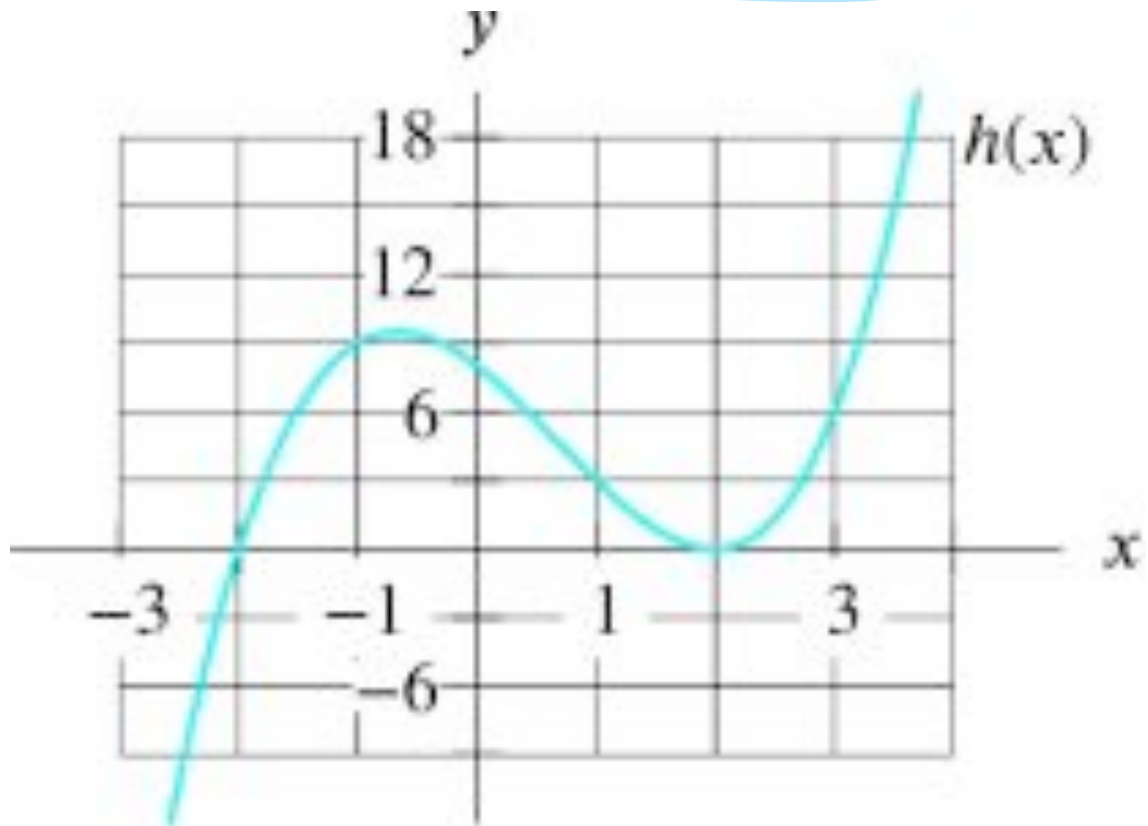C.   Neither

D.   Parts concave up
     and parts concave down

Figure 2.7

Question 6

Where is the value of the function $h(x)$ equal to zero?

A. (2,0) & (0,8)

B. Only (-2,0)

C. Only (0,8)

D. (2,0) & (-2,0)

Question 7

The function $f(t) = 2\sin t + A$ has no zeros if A is greater than:

A. 1

B. 2

C. 0

D. -2

Sample Plicker "LiveView" Output

6.3 #7Determine the value of k in Figure 6.7

Correct: 44%
Total: 27/31
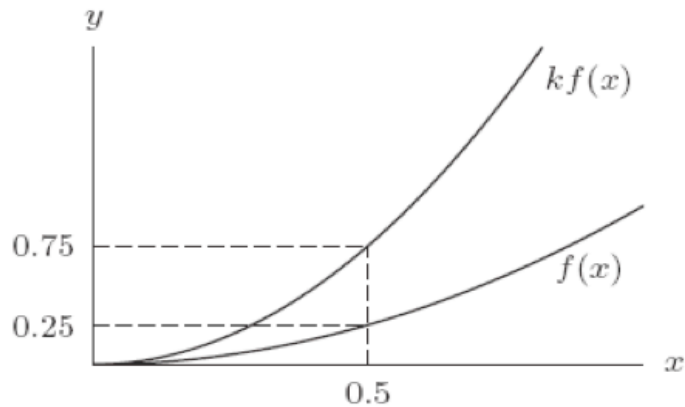
Figure 6.7

A. 0.5

B. 0.75

C. 1.5

D. 3.0
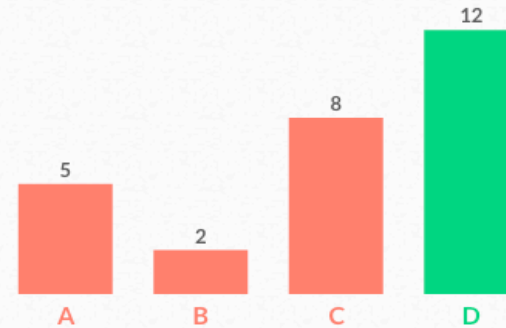
Answer	Card #	▲First name	Last name
D	17	AJ	
D	26	Andrew	
—	27	Andrew	
D	12	Anthony	
C	31	Ben	
D	29	Brandon	
D	10	Bridget	
A	2	Casey	
D	11	David	
C	9	Elizabeth	
D	5	Emily	
C	8	Garrett	
D	13	Gregory	

Exit Tickets

* An "Exit Ticket" is a problem or question posed at the end of class. It is a quick way to get feedback on student understanding.

* Depending on the task, I give students about 3-5 minutes to complete their work on the problem and hand in their cards.

* The cards then essentially become their "ticket" out of class. Sometimes, I choose a topic from that day's lesson, but often I choose a topic from the prior lesson.

Exit Tickets (cont'd)

* Additionally, I have a rule that when working the problem, students may use their notes, their books, or even discuss their work with other students, but I will not answer any questions or give help.

* The unanticipated side-effect of this policy was that it sparked discussion amongst the students on solution strategies. Since I, the teacher, was not an allowed resource, they had to rely on each other.

Exit Tickets (cont'd)

* One of the important feature of this assessment is that it is *ungraded*. There are no points awarded for the work.

* I assess the work done as "well done", in which case the student receives a "☺", or "not yet" in which case, the student receives some feedback on what went wrong.

* The next day in class we discuss the correct solution. It is up to them to look over their work and see where they went wrong.

Exit Tickets (cont'd)

* When we are dealing with a particularly challenging topic, using exit tickets allows me to track student progress over several lessons as well.

* I will give exit ticket problems on a single topic for several days in a row.

* Almost always, the majority of the students do better each day. I can see their progress, but more importantly *they* can see their progress.

Exit Tickets - My Favorite No

* Another important aspect of formative assessment is for students to learn to value mistakes. Mistakes provide valuable learning opportunities.

* According to cognitive science research, making mistakes actually causes more neurological activity than completing a task perfectly. (Boaler, 2016, p.11)

* That is why, when going over Exit Ticket solutions, I select "My Favorite No." Basically, it is my favorite wrong solution.

Example of "My Favorite No"

Exit Ticket: Without using your calculator, sketch a graph of this function:
$$g(x) = (x-1)^2(x+1)(x-3)$$
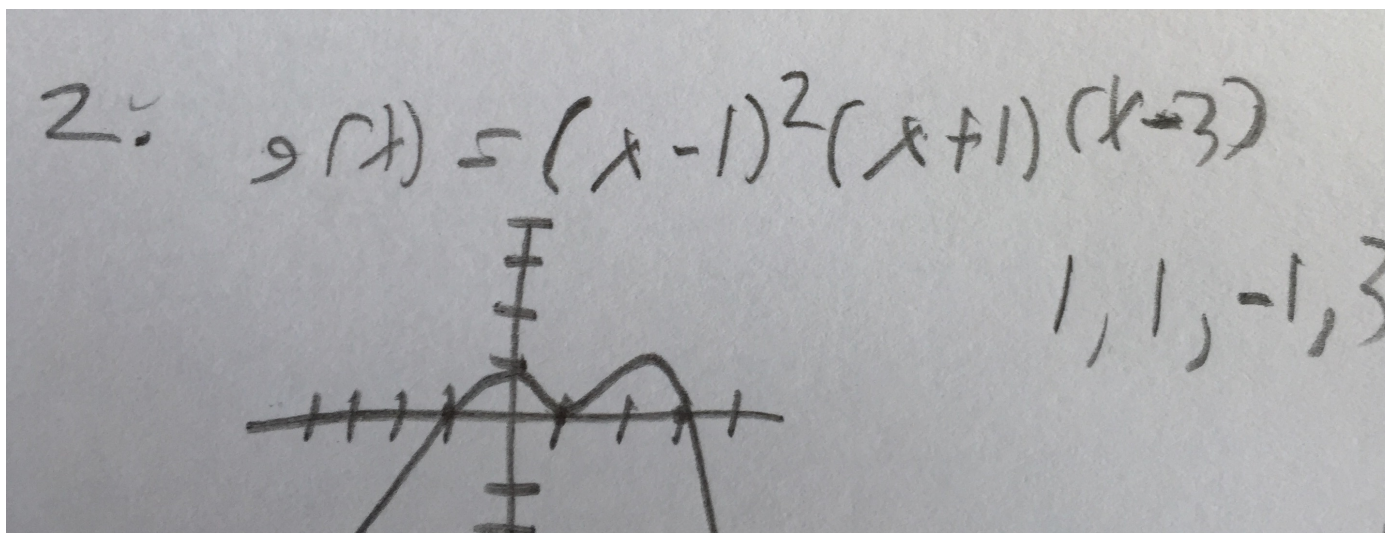
Many people correctly identified the zeros, but failed to determine whether it opened up or down and failed to find the y-intercept. This is a good reminder to look at the degree of the polynomial as well as looking at whether the "k" is positive or negative.

There are zeros at x=1, x=-1, and x=3. The one at x=1 is a "double" zero. We also know that the y-intercept is at (0, -3), and that this is a 4th degree polynomial that opens up. See next slide for my sketch.

My Graph

$$g(x) = (x-1)^2(x+1)(x-3)$$
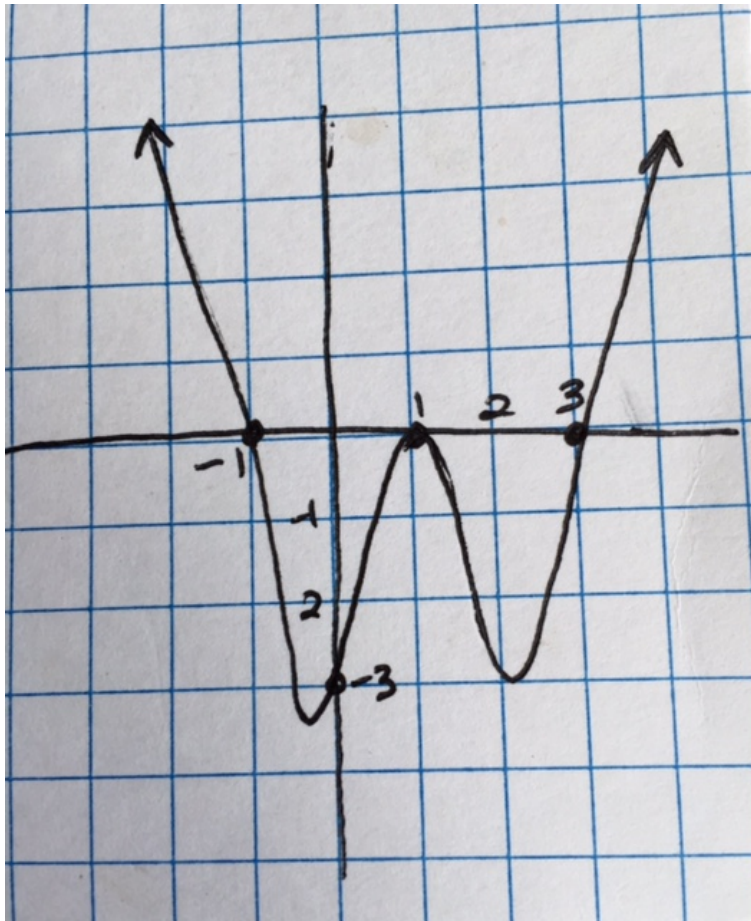
There are zeros at x=1, x=-1, and x=3. The one at x=1 is a "double" zero. We also know that the y-intercept is at (0, -3), and that this is a 4th degree polynomial that opens up.

Exit Tickets (cont'd)

* I have found that using ungraded formative assessment is a good way to start students on the path to becoming more independent learners.

* The lack of a grade makes it more of a "low threat" experience. Also, students tend not to look past the grade on an assessment.

* They will see a "B" and think, "Ok, good enough," and not dig any deeper than that.

* Without a grade, they must examine their work more closely to see why they did not get a "☺".

In closing...

"When teachers give assessments to students, they are faced with an incredible opportunity: to provide students with information about their learning – rather than their achievement – which accelerates pathways to success and gives students powerful growth mindset messages about mathematics and learning."

(Boaler, 2016, p.168-169).

References

Boaler, J. (2015). *Mathematical Mindsets: Unleashing Students' Potential through Creative Math, Inspiring Messages and Innovative Teaching*. San Francisco, CA: Jossey-Bass Publishers.

Cooper, D. (2011). How Should I assess Learning in the Mixed-Ability Class? In *Redefining Fair:How to Plan, Assess, and Grade for Excellence in Mixed-Ability Classrooms* (pp.73-88). Bloomington, IN: Solution Tree Press.

Dweck, C. (2006). *Mindset: The New Psychology of Success*. New York, NY: Random House Publishers.

Wormeli, R. (2006). The Relative Nature of Grades and Their Definitions. In *Fair Isn't Always Equal: Assessing and Grading in the Differentiated Classroom* (pp.89-100). Portland, ME: Stenhouse Publishers.

Questions?

If you would like a copy of my slides or other materials, or have further questions, you can email me at

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Thank you for your time!