

# Building a Growth Mindset for Math

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**Supporting Productive Failure**

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Scholastic Education

# Make it “relevant”

# Make it “fun”

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Historical tendency: “You know how kids love...”

- video games
- computers
- television
- radio
- movies
- magic lanterns



# What motivates humans, including students?

## Center on Education Policy

- Competence (progress)
- Control/Autonomy (agency)
- Interest/Value (purpose)
- Relatedness (community/status)

Also characteristics of Ripley's high performers

And the games kids (and we) find addictive

**Appendix: How Do Different Experts View the Dimensions of Student Motivation?**

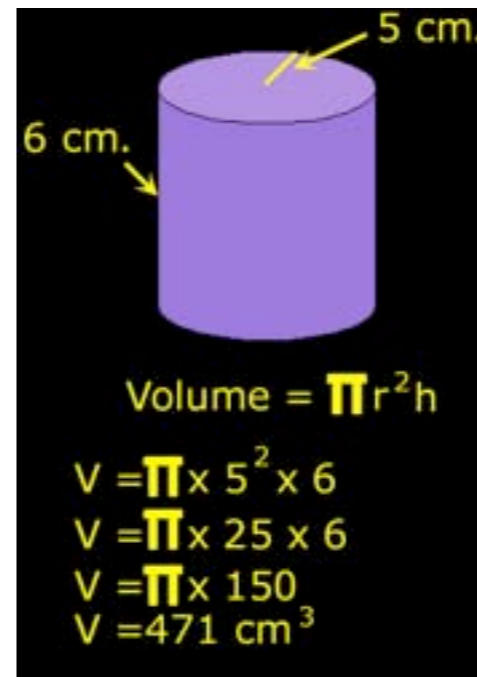
Researchers	Major theories of researcher	Dimensions of motivation			
		Competence	Control/autonomy	Interest/value	Relatedness
		The students believes he or she has the ability to complete the task	The student feels in control by seeing a direct link between his or her actions and an outcome, and retains autonomy having some choice about whether or how to undertake the task	The students has some interest in the task or sees the value of completing it	Completing the task brings the student social rewards, such as a sense of belonging to a classroom or other desired social group, or approval from a person of social importance to the student
Ryan & Deci <sup>1</sup>	Self-determination theory suggests a framework of three factors that must be met for a task to hold interest	Competence is one of three core tenets of self-determination theory People have a need to feel effective	Autonomy is one of three core tenets of self-determination theory People have a need to feel in control over their own choices and decide their own direction	People need either an intrinsic or extrinsic interest in the task for it to be of importance	Relatedness is one of three core tenets of self-determination theory People desire to interact with and be connected to others
Pinkich <sup>2</sup>	Motivational science perspective identifies five "social-cognitive constructs" that interact to lead to higher motivation	Higher confidence in one's abilities leads to higher motivation	Personal goals are essential to motivation "Mastery" goals are more desirable than "performance" goals	Higher levels of interest lead to higher motivation Stronger perceptions of value lead to higher motivation	Social goals are as influential as academic or professional goals Supportive, caring relationships are important for high motivation
Seifert <sup>3</sup>	Reconstructing motivation theory surveys several other theories to compile five "behavior patterns" that distinguish different causes of motivation	Those with a mastery pattern of behavior believe they have a high degree of competence Those with a learned helplessness pattern believe they have low competence Those with a work avoidant pattern believe they have high competence	Those with a mastery pattern feel they are in control of outcomes The failure avoidant think they have no control over their success or failure The work avoidant choose not to engage in work Those with learned helplessness believe their efforts are futile	Those with a mastery pattern see worth in tasks that can improve skills/understanding The work avoidant think their work has no worth The failure avoidant see no value in a task they might fail Those with learned helplessness see no worth in attempting any task	The failure avoidant fear others' judgment Those with learned helplessness attribute all success to others Those who are passive-aggressive withhold effort out of wrath towards others

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<http://www.cep-dc.org>

# 1. Interest/Value (Purpose)

- “When will I ever use this?”
- When will you ever use THIS?!?
- Short-term value: It’s interesting
- Long-term value: It takes you forward. “I need this for...”
- It doesn’t work to TELL students that it’s important for them.



# Make it Interesting: Which Number Doesn't Belong?

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9

16

25

43

accessible

discussable



## Use Drama

<http://blog.mrmeyer.com/?p=16470>

Dan Meyer's Math in 3 Acts

# What good tutors do (VanLehn, et.al., 2003)

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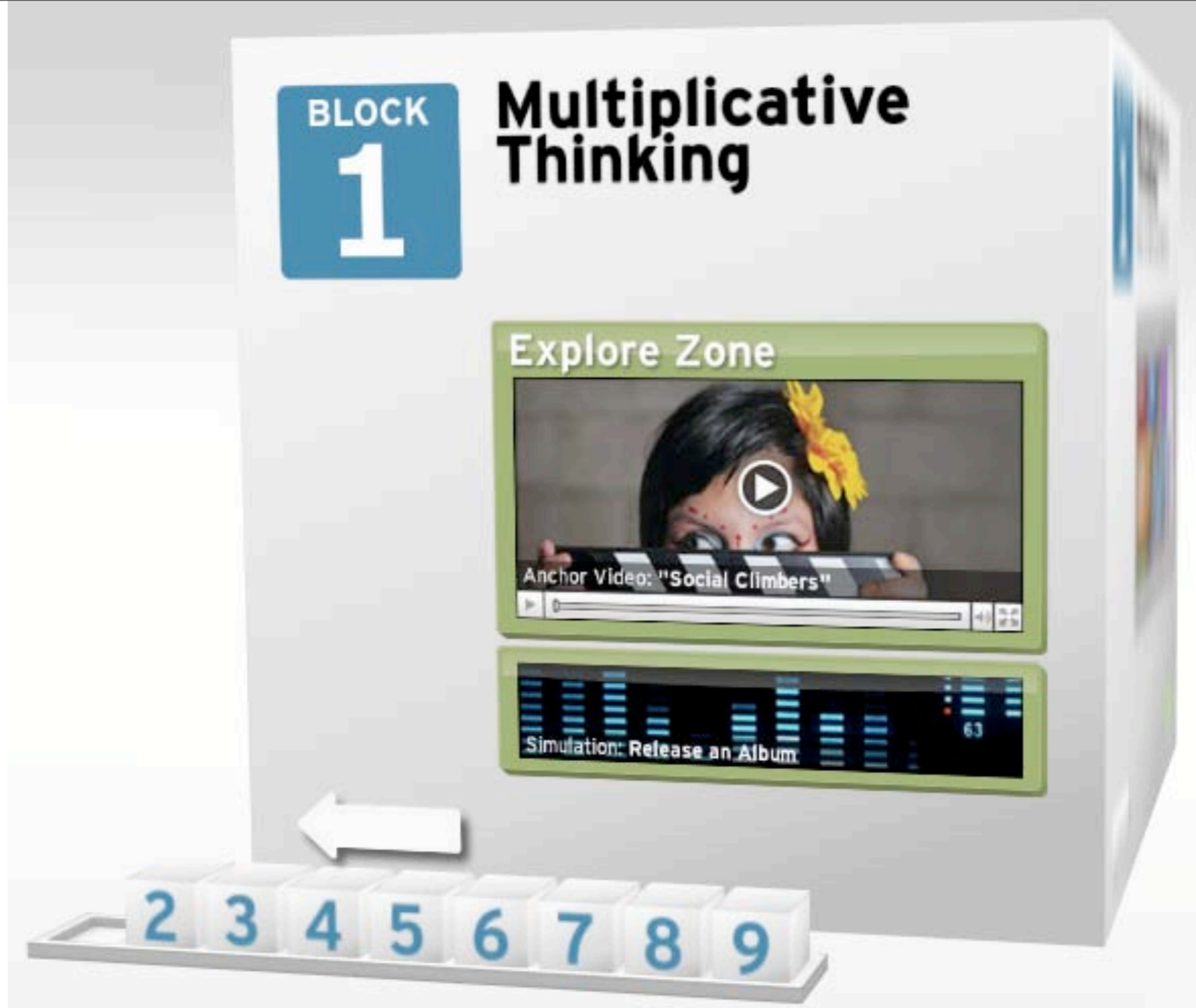
- let the student reach an impasse (the drama creates a reason to learn)
- prompt them to find the right step and explain it (make sure the students try it...and can explain it)
- provide an explanation only if they have tried and failed to provide their own explanation

## Moorpark Zoo: Managing Exotic Animals



Long Term Value

Situating math in real stories



<http://teacher.scholastic.com/products/math180/program-components-student-teacher.htm>

Start with Application

and trial and error learning



**Fundraiser**

I want to record an album  
It's going to be amazing!

PLEGGED 90% FUNDED \$9000 DAYS TO GO 10

The interface features a cartoon character with black hair and a goatee, wearing a white t-shirt and playing a white electric guitar. The background is a tropical beach scene with palm trees and turquoise water. A circular profile picture of the character is shown in a white box. Below the text is a progress bar that is 90% full. At the bottom of the fundraiser box, there are three columns of data: 'PLEGGED 90%', 'FUNDED \$9000', and 'DAYS TO GO 10'. A small speaker icon is in the top left corner of the fundraiser area.

Start Over Go On

Start with Application

a reason to use math



**RUN**

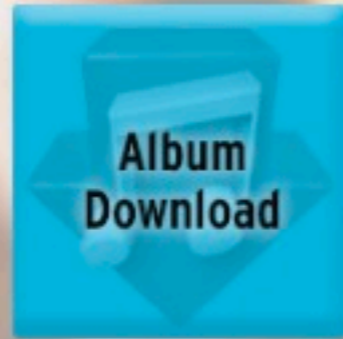
### WHAT HAPPENED WITH OTHER BANDS?

Donation amount	Number of donors	Total amount raised
\$50	12	$\$50 \times 12 = \$600$
\$40	25	$\$40 \times 25 = \$1000$

SET UP REWARDS



DONATION: \$10



DONATION \$



DONATION \$



DONATION: \$250



DONATION: \$1,000

RAISE FUNDS  
SET UP REWARDS

SHARE VIDEO  
CHOOSE TIME

Start Over

Go On

# Risk-free Exploration

Learning from Mistakes



GOAL

\$10,000

SHARE VIDEO

FOLLOWERS 406

THEIR FOLLOWERS 6,739



Working on our first Album, can you help?

Link to Fundraiser  Add Tag  Add Mention  Ask to Share

Working on our first Album, can you help?#Indie Listen to my Album! Share this!



Robot Vampire 4:21

RAISE FUNDS

SET UP REWARDS

SHARE VIDEO

CHOOSE TIME

Start Over

Go On

Personalized

Student Choice & Ownership



GOAL

DAY 30: \$13,014

\$10,000

### EXPLAIN YOUR CHOICES

1. Did you meet your goal?

Yes.

2. If each person who donated gave \$1 more, about how much would you raise?

Over 400 donated, so if each gave \$1 more I would have raised over \$400 more.

3. What will you do differently next time?

Submit

# Reasoning with Results

Learning from Mistakes



Cash	Stock	Net	Rank	
12099.80	34332.00	46431.79	410	
US Markets Close In 0:45:20				
Start Typing for Stocks...			Quote	
Current	Pending	Executed		
Qty	Avg Price	Last Price	Profit&Loss	
<b>B</b>	x634	\$33.07	\$33.13	<b>\$38.04</b>
Barnes Group, Inc.			Market Value = \$21004.42	
<b>VZ</b>	x10	\$50.04	\$51.59	<b>\$15.5</b>
Verizon Communications Inc.			Market Value = \$515.9	
<b>T</b>	x10	\$35.65	\$35.97	<b>\$3.2</b>
AT&T Inc.			Market Value = \$359.7	
<b>MSFT</b>	x61	\$31.55	\$31.54	<b>-\$0.61</b>
Microsoft Corporation			Market Value = \$1923.94	
<b>G</b>	x10	\$20.9	\$20.57	<b>-\$3.3</b>
Genpact Limited C			Market Value = \$205.7	
<b>Y</b>	x1	\$405.03	\$396.056	<b>-\$8.974</b>
Alleghany Corporation			Market Value = \$396.056	
<b>R</b>	x20	\$62.43	\$60.55	<b>-\$37.6</b>
Ryder System, Inc.			Market Value = \$1211.0	
<b>C</b>	x100	\$52.33	\$51.73	<b>-\$60.0</b>
Citigroup Inc.			Market Value = \$5173.0	
<b>H</b>	x84	\$46.44	\$42.17	<b>-\$358.68</b>



Simulations

Make Learning Purposeful

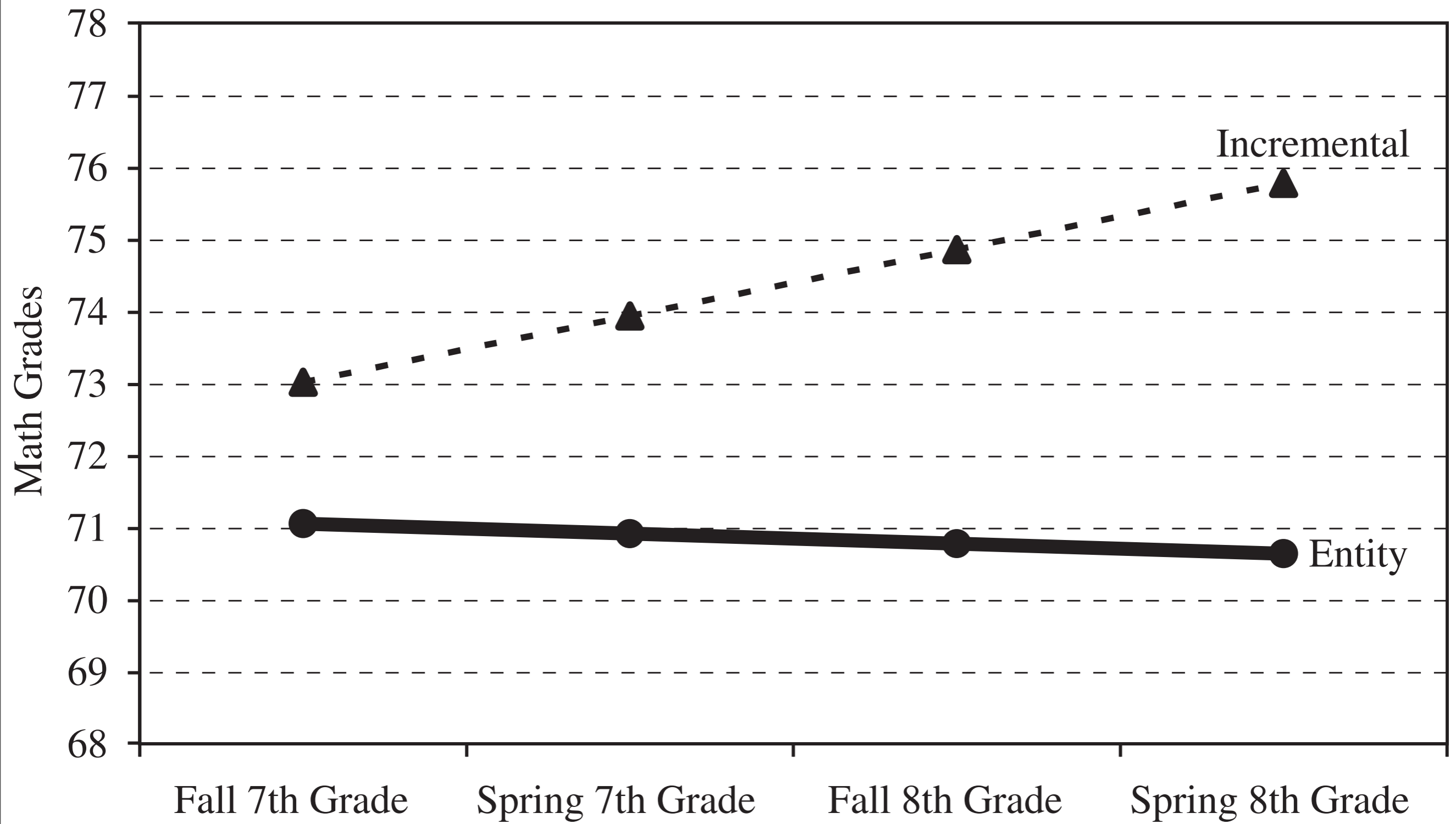
## 2. Competence AND Confidence

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- Perceived ability matters more than actual ability
- Girls often do better in math/science than boys but feel less capable
- Fixed vs Growth Mindset

“The **brain** is  
like a **muscle**.  
Giving it a **hard**  
**workout** makes  
it **stronger.**”

– Carol Dweck, Ph. D.  
Author of *MindSet*



# Growth Mindset Results

Blackwell, L. S., Trzesniewski, K. H., & Dweck, C. S. (2007). Implicit Theories of Intelligence Predict Achievement Across an Adolescent Transition: A Longitudinal Study and an Intervention. *Child Development*, 78(1), 246–263. Retrieved from <http://onlinelibrary.wiley.com/doi/10.1111/j.1467-8624.2007.00995.x/full>



What's Your Fixed  
Mindset?

How many of your kids  
are video game players?

# Fixed vs Growth Mindset

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## Fixed Mindset

- “That came easily to me, I must be good at it.”
- “I’m not...”
- avoid failure
- mistake = can’t do (I’m not)

## Growth Mindset

- “That came easily to me, I wonder how good I can get.”
- “I can if...”
- look for challenges
- mistake = learning opportunity

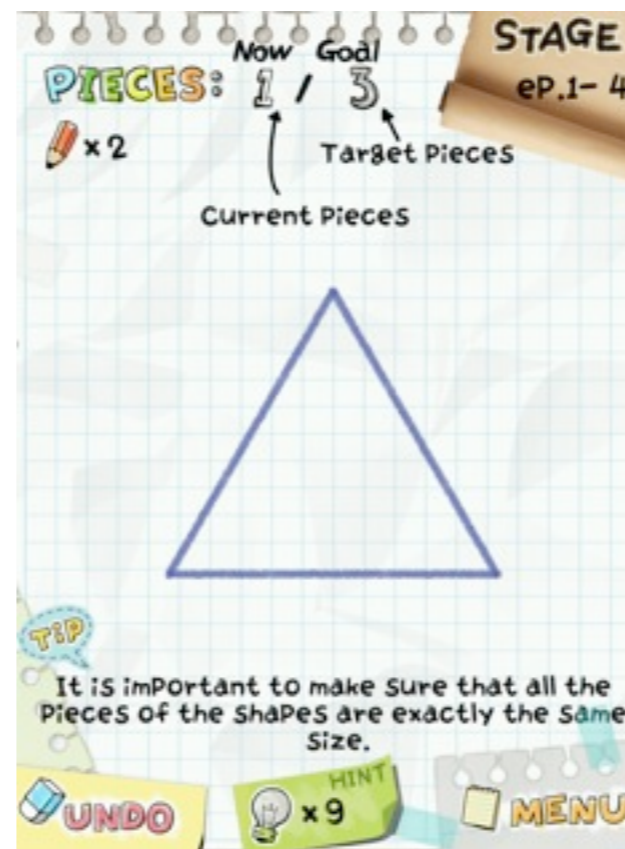
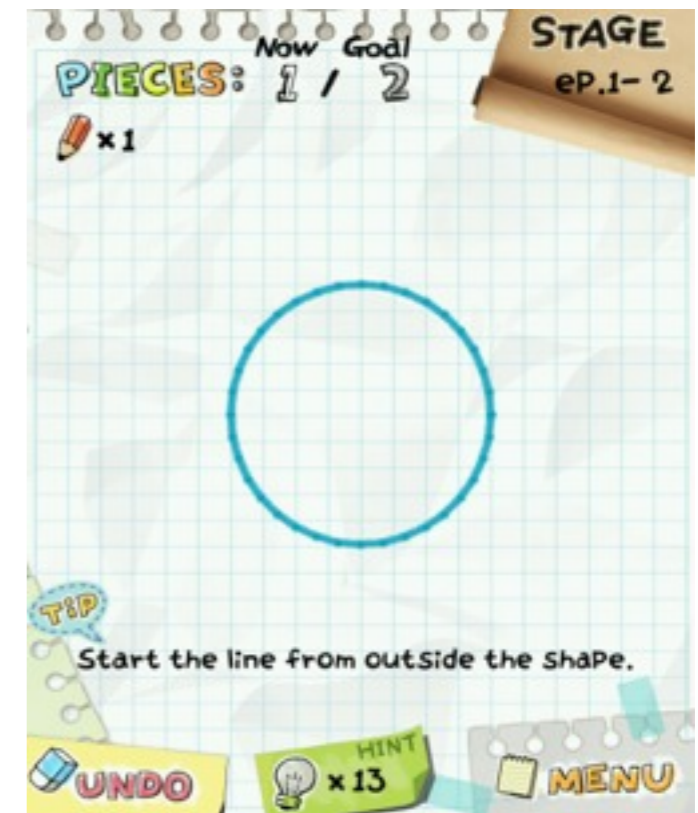
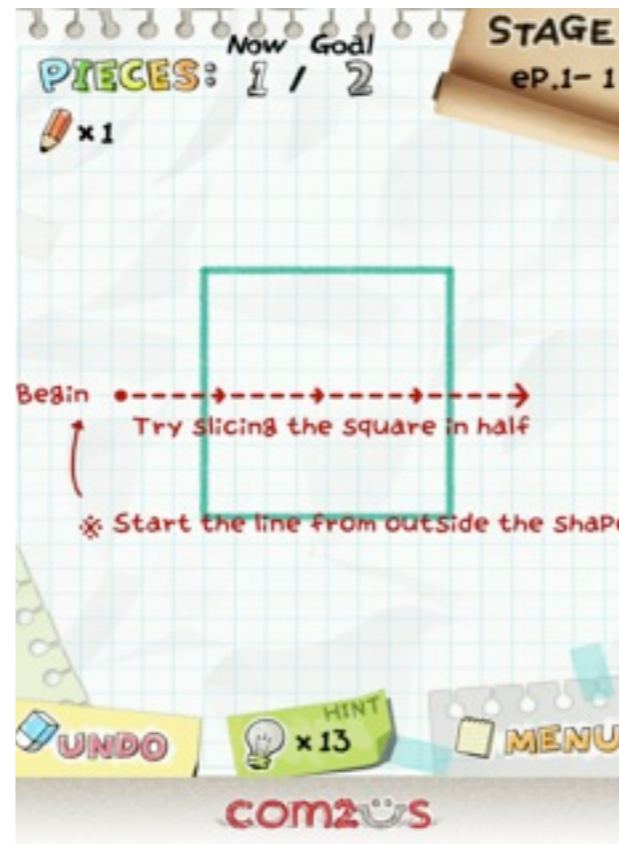
# Shift relationship with failure

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- “struggle” and “mistakes” are not typically rewarded in school
- In games, players fail 80% of the time. Success is the exception.
- In school, for struggling students, mistakes = “I’m stupid.”
- In good games, mistakes = “I need to try again.” “What can I do differently?”

# Give Students a Running Start

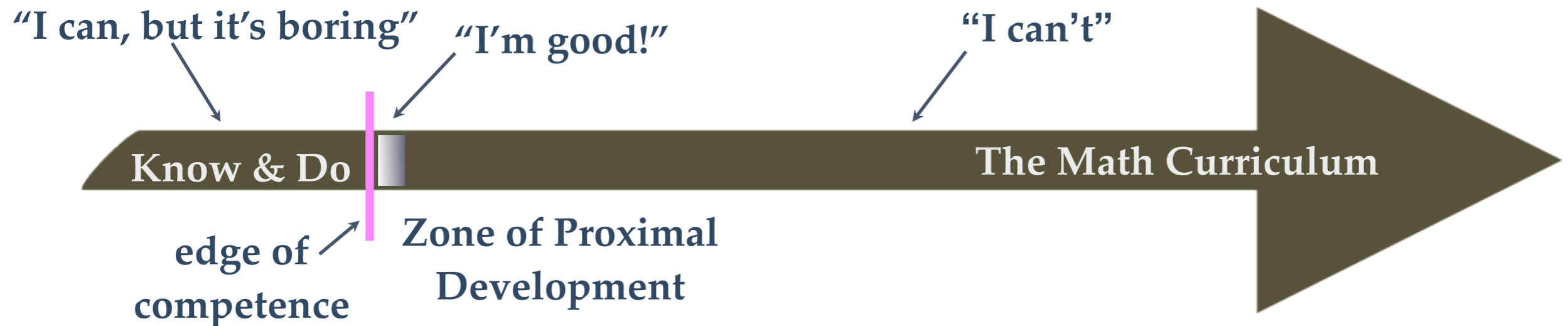
- we persevere when we believe we can succeed
- but we need evidence
- shaky confidence + early failure = total shutdown
- games provide a gradual slope



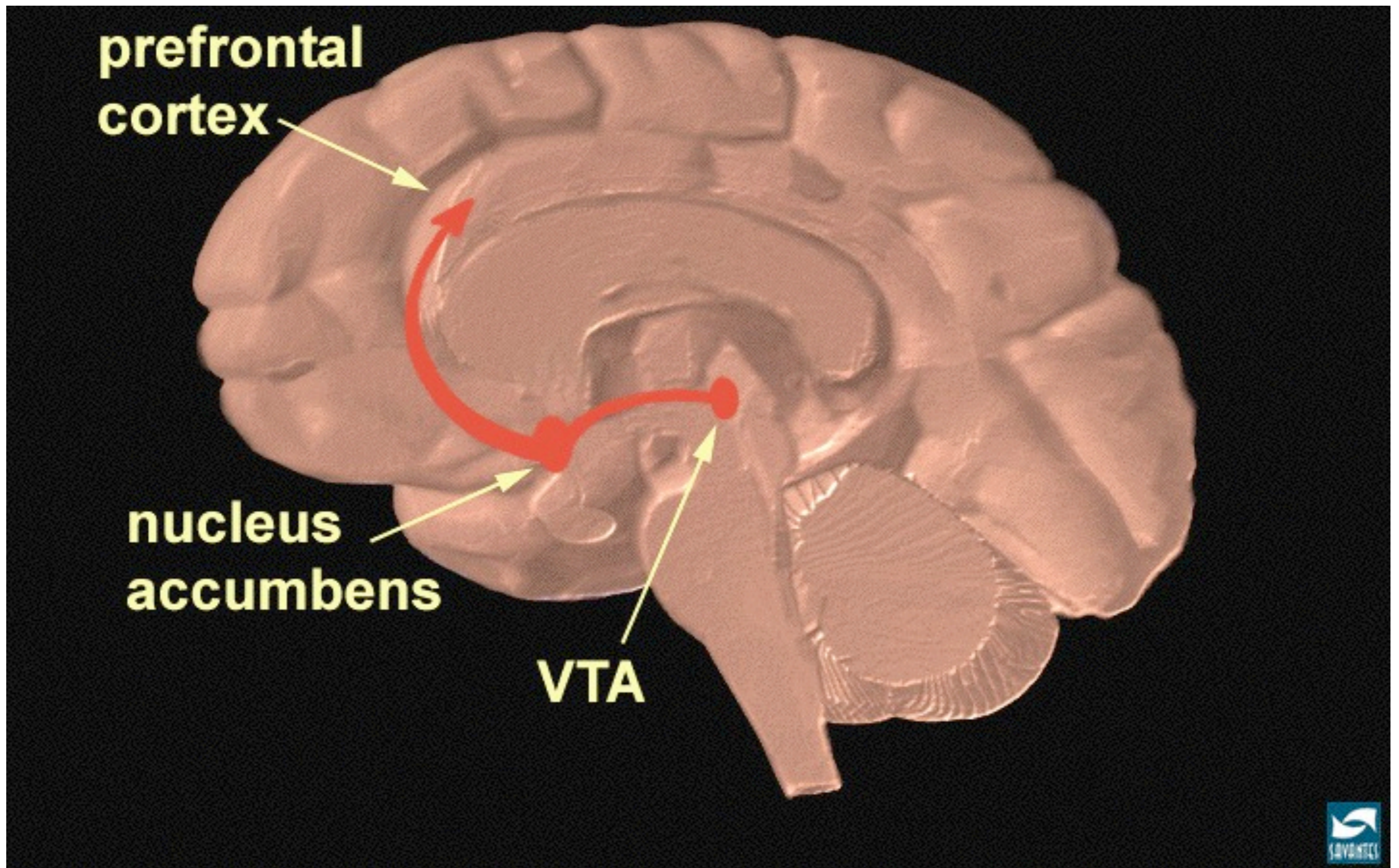
Slice It! -- com2us.com

# But move quickly to the edge

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Just the Right Frustration Can be Very Satisfying



## The reward pathway

giving yourself a dopamine hit

# Shift the Reference Point

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- Set the expectation for struggle

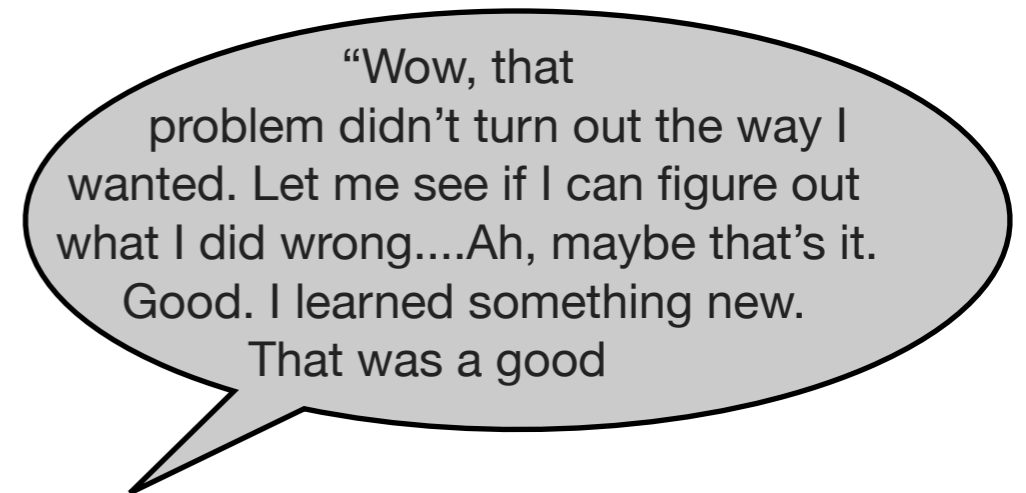
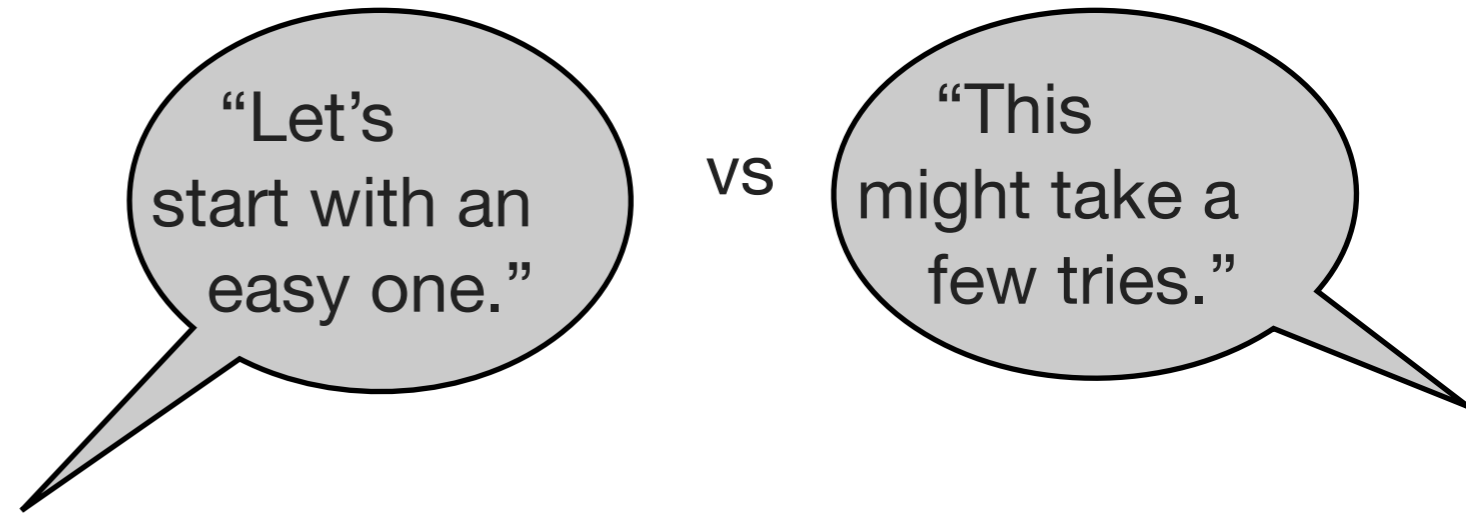


- When low SES or minority students struggle at college...
  - don't belong, drop out
  - but if expect to struggle, then more likely to stay and graduate

# Words, Models, & Knowledge

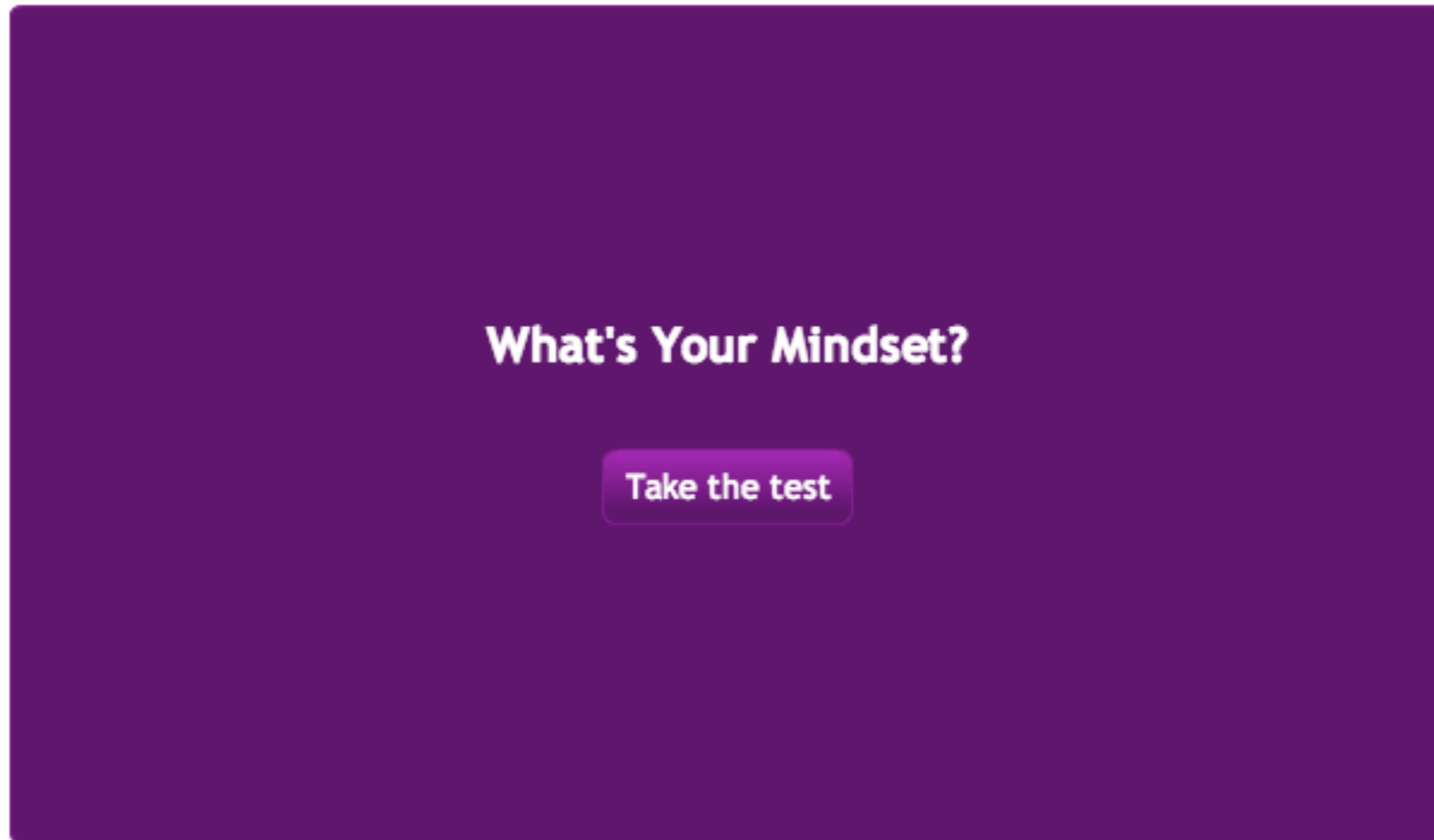
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- with words
- by modeling with your own mistakes
- using examples
- by teaching about growth mindset



## Quiz: What's Your Mindset

In some schools, a "growth mindset," or the idea that people can improve by seeking challenges and learning from mistakes, has reformed how teachers approach their instruction. How do you approach learning? Are certain skills naturally born to students, or can they really improve by effort alone? Using questions from **Mindset Works**, we've put together an exercise (not a test!) for you to try out.



Check your own  
Mindset

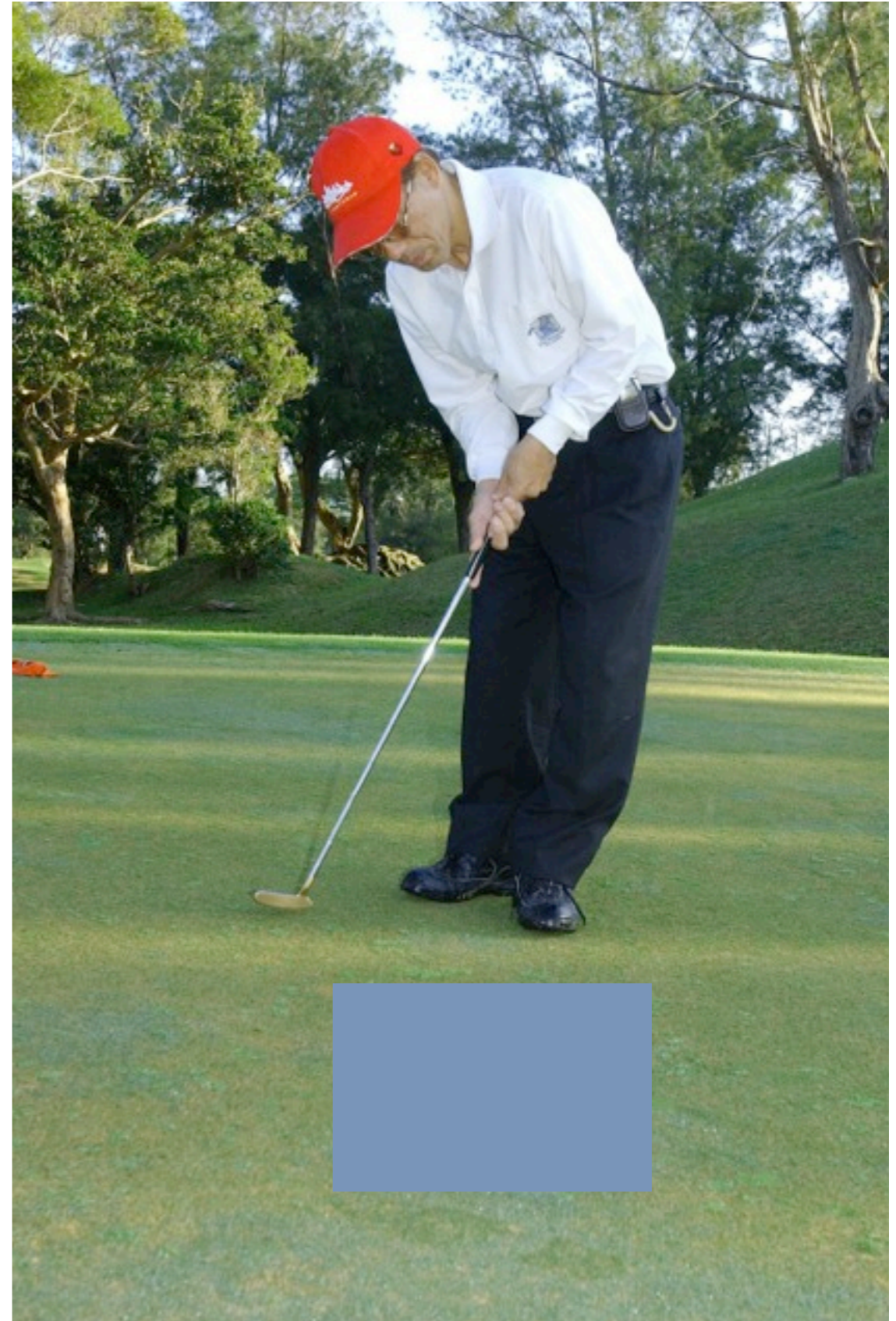
<http://www.mindsetworks.com/>

EdWeek

# Use Appropriate Feedback

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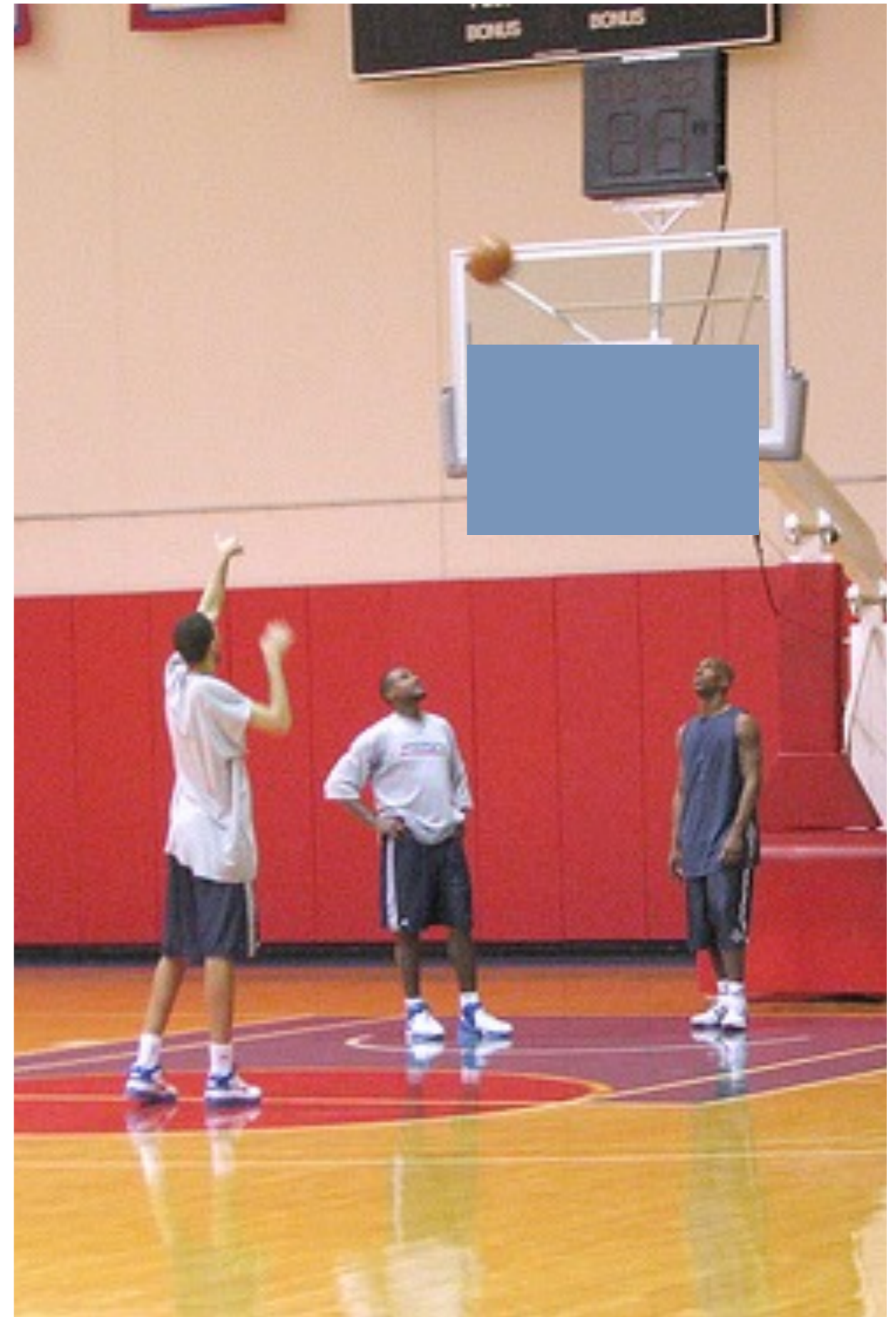
- Can't learn from failure without feedback
- Reinforce the right
- Correct the wrong
- Imagine practicing putting without seeing if the ball goes in the hole



# Corrective Feedback

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- or practicing free throws without seeing if the ball goes in the basket



# Corrective Feedback

- or practicing math procedures without knowing if the answers are correct
- digital games provide immediate feedback and can be incredibly failure tolerant
- so do simulations and visual models
- try...see results...revise...repeat
- provides a sense of control

NAME \_\_\_\_\_  
Math Assignment

$\begin{array}{r} 95 \\ + 42 \\ \hline \end{array}$	$\begin{array}{r} 81 \\ + 69 \\ \hline \end{array}$	$\begin{array}{r} 49 \\ + 72 \\ \hline \end{array}$	$\begin{array}{r} 33 \\ + 4 \\ \hline \end{array}$	$\begin{array}{r} 70 \\ + 3 \\ \hline \end{array}$
$\begin{array}{r} 96 \\ + 70 \\ \hline \end{array}$	$\begin{array}{r} 62 \\ + 40 \\ \hline \end{array}$	$\begin{array}{r} 62 \\ + 75 \\ \hline \end{array}$	$\begin{array}{r} 62 \\ + 18 \\ \hline \end{array}$	$\begin{array}{r} 26 \\ + 15 \\ \hline \end{array}$
$\begin{array}{r} 74 \\ + 12 \\ \hline \end{array}$	$\begin{array}{r} 72 \\ + 20 \\ \hline \end{array}$	$\begin{array}{r} 64 \\ + 64 \\ \hline \end{array}$	$\begin{array}{r} 78 \\ + 33 \\ \hline \end{array}$	$\begin{array}{r} 51 \\ + 42 \\ \hline \end{array}$
$\begin{array}{r} 52 \\ + 17 \\ \hline \end{array}$	$\begin{array}{r} 12 \\ + 49 \\ \hline \end{array}$	$\begin{array}{r} 85 \\ + 72 \\ \hline \end{array}$	$\begin{array}{r} 96 \\ + 67 \\ \hline \end{array}$	$\begin{array}{r} 42 \\ + 95 \\ \hline \end{array}$



Block 4 > Topic 2 > Lesson 2: Use Models to Add Fractions  
LEARN ZONE

Use the Fraction Pieces mTool to add fractions. Think Try Practice Master

Step 2

Step 3: Complete the equation.

$$\frac{1}{2} + \frac{2}{16} = \frac{\square}{\square}$$

Reset Go On

Step 4

Fraction Pieces

Fast Track Example Go On

# Show Progress

- Progress -- Harvard Business Review #1 big idea for 2010
- Marketers motivating us
- Motivating ourselves
- Making long waits a little more tolerable

THE HBR LIST

LEADERSHIP  
TERESA M. AMABILE AND STEVEN J. KRAMER

## What Really Motivates Workers

**Understanding the power of progress**

ratings of their motivation and emotions, shows that making progress in one's work—even incremental progress—is more frequently associated with positive emotions and high motivation than any other workday event. For example, it was noted on 76% of people's best days, when their reported moods were most buoyant, and on only 25% of their worst. (The exhibit "What Happens on a Great Workday?" shows how progress compared with the other four most frequently reported positive events.)

**The Breakthrough Idea** As a manager of people, you should regard this as very good news. The key to motivation turns out to be largely within your control. What's more, it doesn't depend on elaborate incentive systems. (In fact, the people in our study rarely mentioned incentives in their diaries.) Managers have powerful influence over events that facilitate or undermine progress. They can provide meaningful goals, resources, and encouragement, and they can protect their people from irrelevant demands. Or they can fail to do so.

This brings us to perhaps the strongest message from this study: Scrupulously avoid impeding progress by hanging

**When workers sense they're making headway, their drive to succeed is at its peak.**

**The Problem** Ask leaders what they think makes employees enthusiastic about work, and they'll tell you in no uncertain terms. In a recent survey we invited more than 600 managers from dozens of companies to rank the impact on employee motivation and emotions of workplace factors commonly considered significant: recognition, incentives, interpersonal support, support for making progress, and clear goals. "Recognition for good work (either public or private)" came out number one. Unfortunately, those managers were wrong.

This was apparent in vivid detail in the diaries we asked these knowledge workers to e-mail us every day. In one end-of-day entry, an information systems professional rejoiced that she'd finally figured out why something hadn't been working correctly. "I felt relieved and happy because this was a minor milestone for me," she wrote, adding that her efforts to enhance a specific version of software were now "90% complete." A close analysis of many such entries, together with the writers' daily





Progress through Levels

How far to go

# Fact Grid

Alex Perez

0+0	0+1	0+2	0+3	0+4	0+5	0+6	0+7	0+8	0+9
1+0	1+1	1+2	1+3	1+4	1+5	1+6	1+7	1+8	1+9
2+0	2+1	2+2	2+3	2+4	2+5	2+6	2+7	2+8	2+9
3+0	3+1	3+2	3+3	3+4	3+5	3+6	3+7	3+8	3+9
4+0	4+1	4+2	4+3	4+4	4+5	4+6	4+7	4+8	4+9
5+0	5+1	5+2	5+3	5+4	5+5	5+6	5+7	5+8	5+9
6+0	6+1	6+2	6+3	6+4	6+5	6+6	6+7	6+8	6+9
7+0	7+1	7+2	7+3	7+4	7+5	7+6	7+7	7+8	7+9
8+0	8+1	8+2	8+3	8+4	8+5	8+6	8+7	8+8	8+9
9+0	9+1	9+2	9+3	9+4	9+5	9+6	9+7	9+8	9+9

My Facts fast 75 focus 0 study 25

EXIT



Click Go to start

GO

## Progress through Skills

<http://www.fasttmath.com/>

FASTT Math Next Generation

## Badges

### Next Badges

<b>EXPERTISE</b> 8/32 <a href="#">See All</a>  <b>MASTER</b> Success Zone Earn 800 points	<b>ACCURACY</b> 2/12 <a href="#">See All</a>  <b>Marine Biologist</b> Learn Zone 3 Streaks of 3	<b>FOCUS</b> 6/16 <a href="#">See All</a>  <b>Hotel Manager</b> Explore Zone Earn 10 SIM stars	<b>PERSEVERANCE</b> 10/18 <a href="#">See All</a>  <b>EMT</b> Brain Arcade Earn 8 stars in Sushi Monster
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### My Badges

TOTAL BADGES EARNED: **22** / 80

[See All My Badges](#)

Student Dashboards

MATH 180

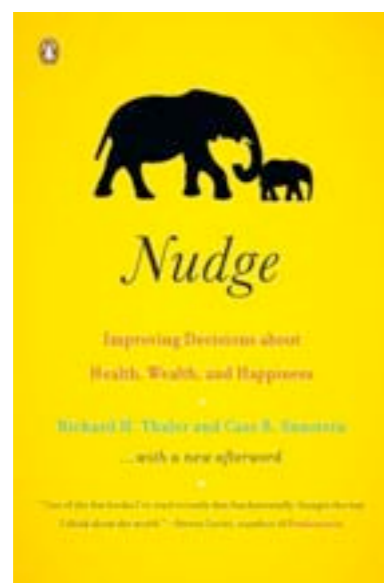
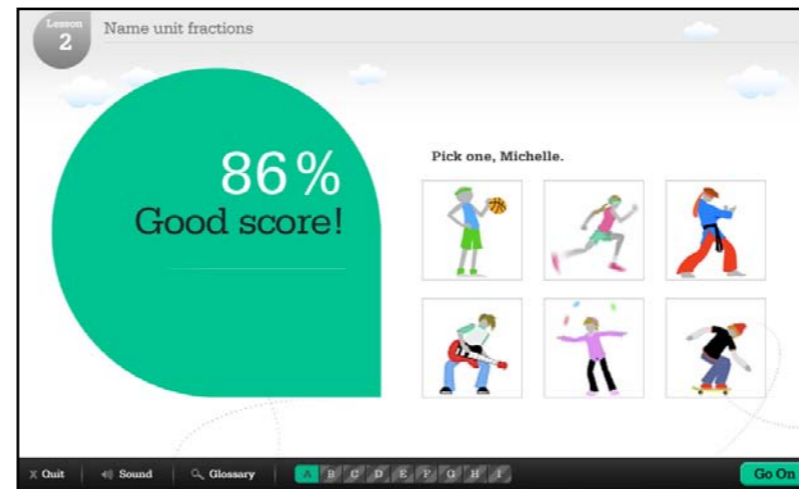
# 3. Control/Autonomy

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- Our brains may not be rational, but they do rationalize
- “If you make me do it, I must not want to do it”
- Intrinsic motivation fueled by choice, undermined by outside control
- But we don’t want to give the choice not to participate

# Choices

- Personalized space
- How to get there
- Strategies
- Choice Architecture



# Manage the Stakes

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$$0.8 + 0.5 = 0.13$$

$$5 + 2 = 8$$



frontier learning

routine performance



failure tolerant

goal of error-free



low stakes

high stakes

# Learning

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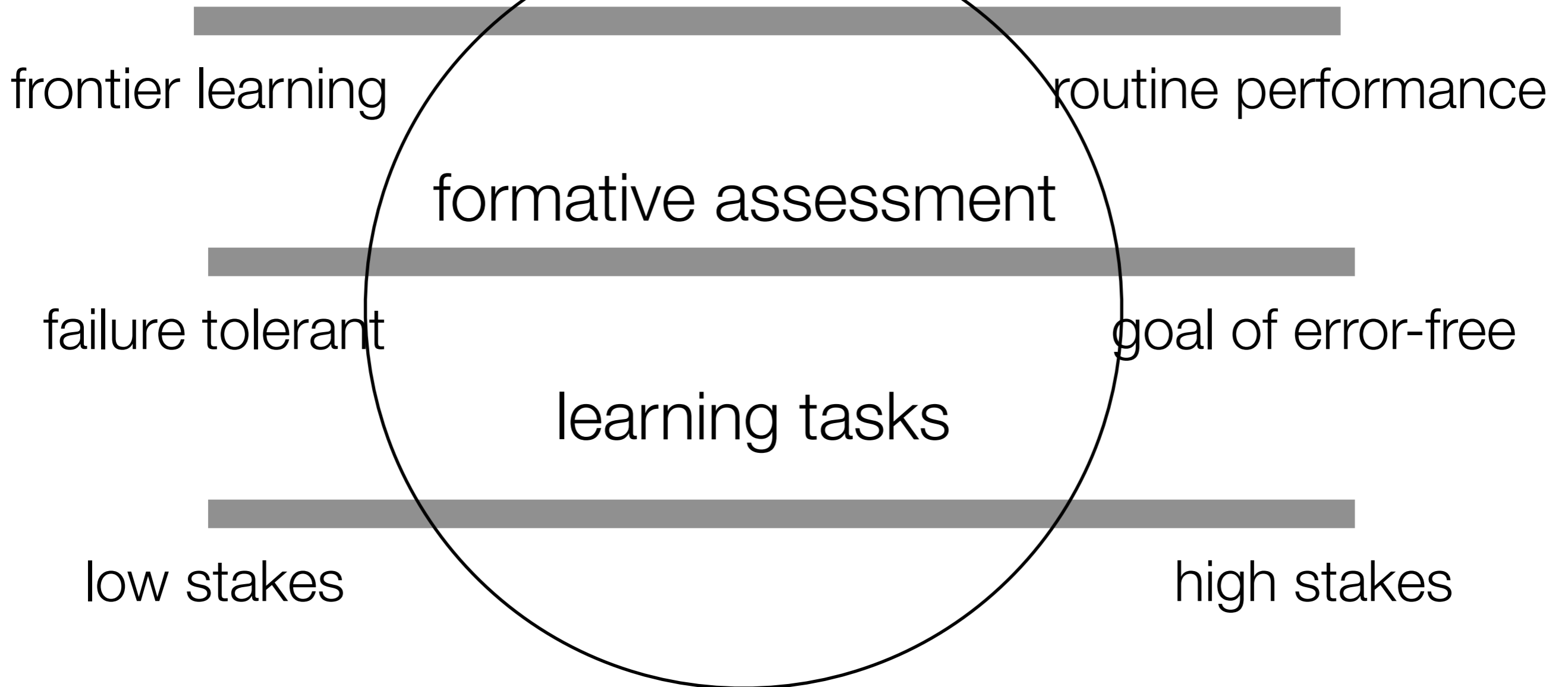
## Instruction



# Practicing

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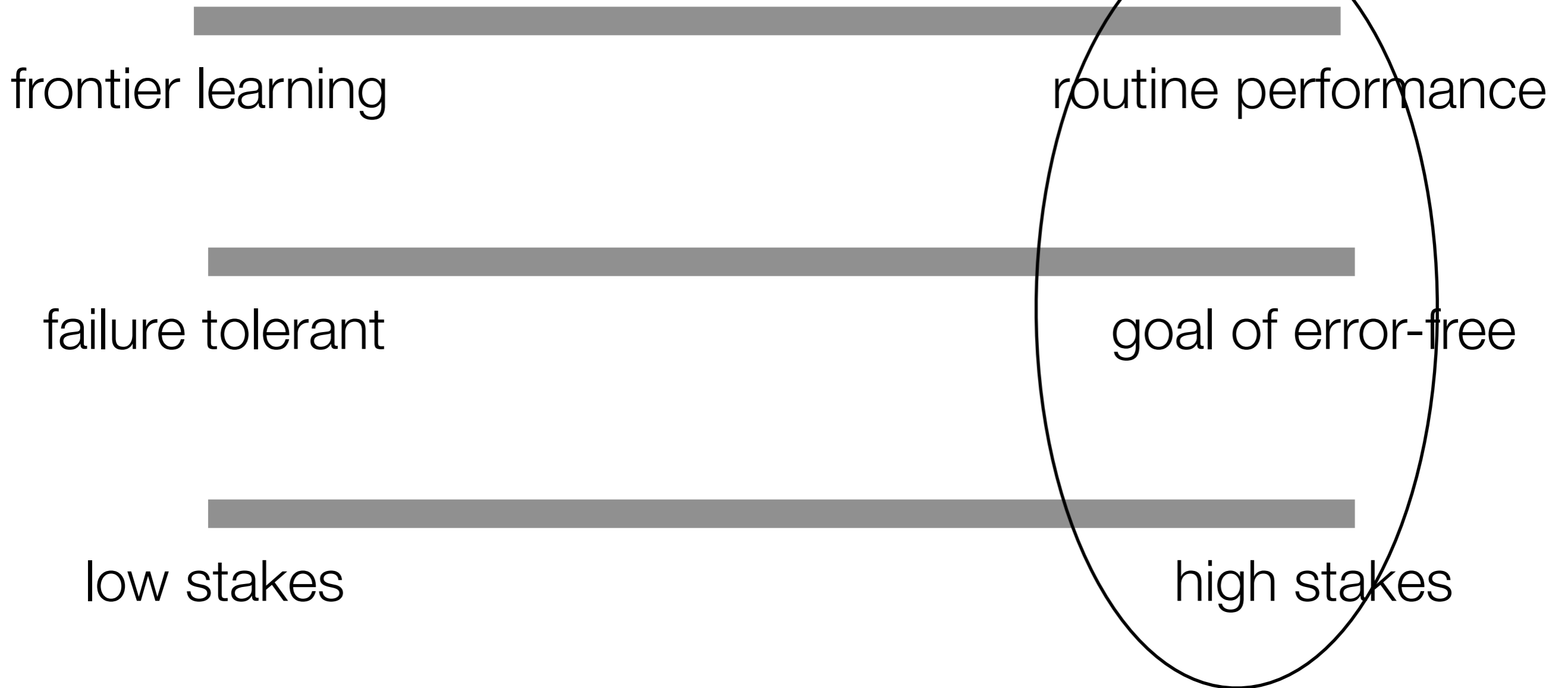
## Practice



# Performing

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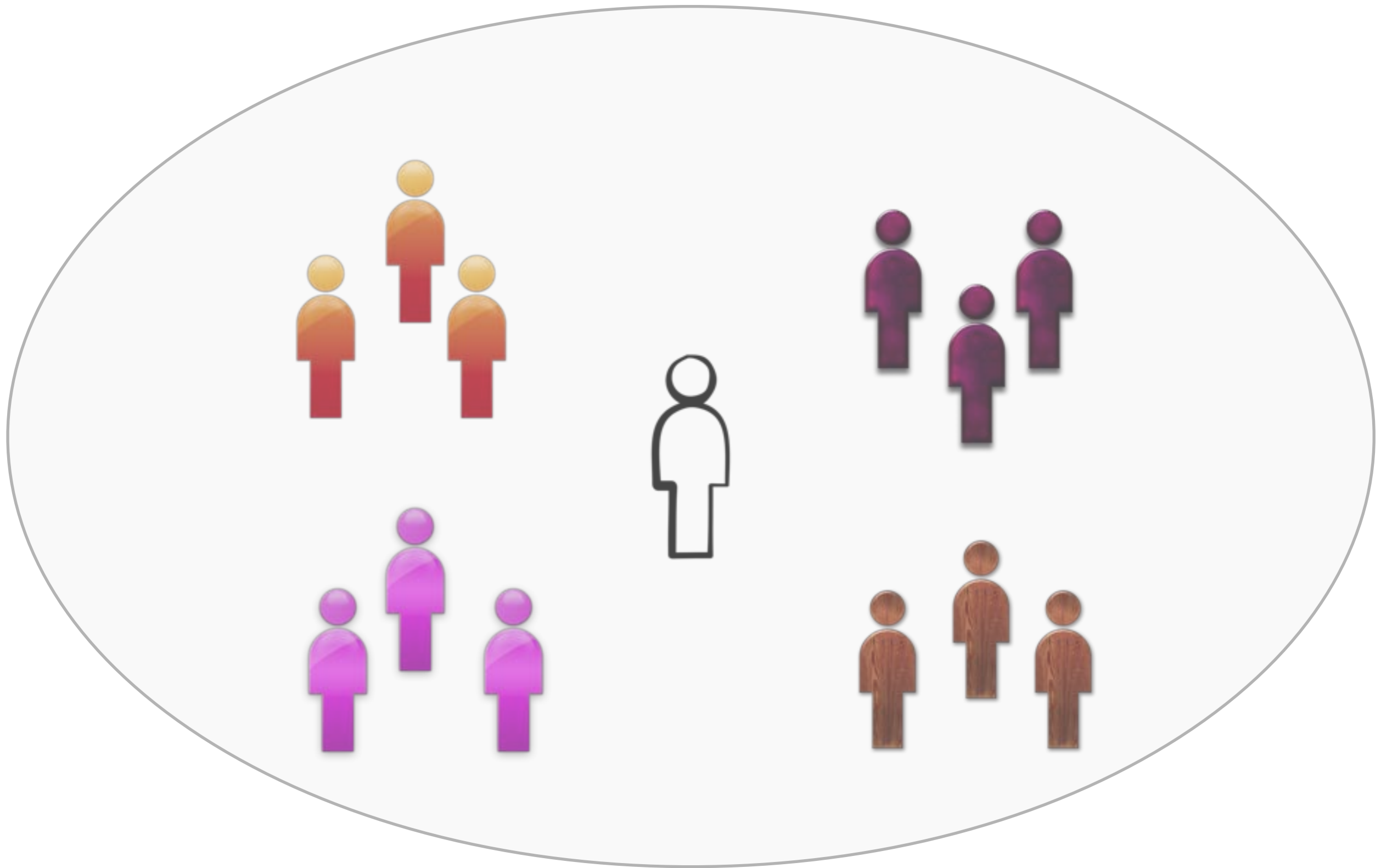
## Performance Assessment



## 4. Relatedness/Community

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- The quest for status may be our most basic evolutionary drive.
- Risky fish get the girls.
- Humans crave social acceptance, and self-efficacy (and grades) are related to peer group support.
- Build a growth mindset classroom culture: What's the “error climate” (Steuer, et al, 2013) in your classroom?



# Mastery vs Performance

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## Mastery

- Personal progress -- where am I vs where I was before
- all about getting better
- best for struggling students who have a history of failure
- choose when and with whom to share growth

## Performance

- Competitive -- where am I compared to others
- all about winning
- good for high performers who think they have a chance of winning
- performance always on display

# Who Cares?

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- Teacher - Student
  - Does the student think the teacher expects only right answers?
  - How does the teacher respond to wrong answers?
  - Do wrong answers lead to poorer grades?
  - What support does the teacher provide after a wrong answer?
  - Are errors analyzed and strategically used for learning?
- Parent - Student
  - Is the parent praising or critiquing the action vs. the child?
- Student - Student
  - Are students willing to take academic risks in front of their peers?

# The power of YET (Carol Dweck)

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- “You haven’t mastered those skills...yet.”
- “You’re not explaining the connection between the graph and the equation clearly...yet.”
- “We haven’t reached all the students...yet”

# Remember

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- Purpose -- give students a reason to learn
- Competence -- let students see themselves getting better to build confidence
- Control/Autonomy -- provide opportunities for choice
- Relatedness -- establish a growth mindset culture

“If you think you can catch  
the bus, you will run for it.”  
- Lee Peng Yee



# Questions? Comments?

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