A Fractal-based Decision Engine for Teaching & Learning

David Kokorowski, PhD
VP Product Management
Pearson

EDI2014

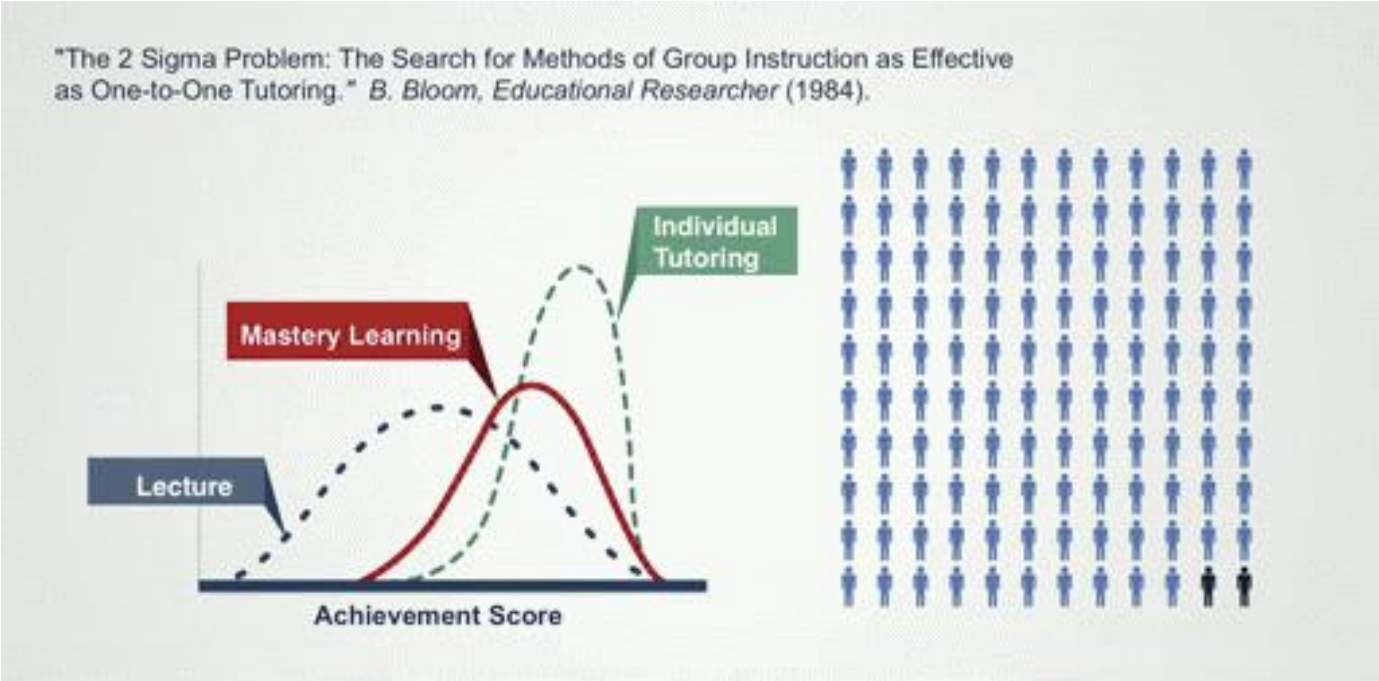

The world's leading
learning company


Measurable impact on
improving lives
through learning

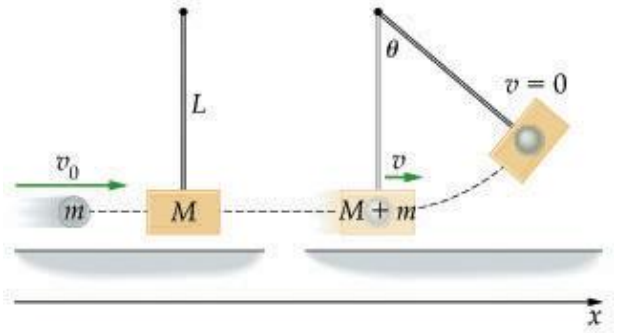
LOCKHEED MARTIN

BOEING

The Two Sigma Problem



MasteringEngineering®



Find an expression for v_0, the initial speed of the fired object.

$v_0 =$ $\sqrt{\frac{(m+M)}{m} 2gL(1-\cos(\theta))}$

reset shortcuts help

Try Again

submit hints my answers show answer review part

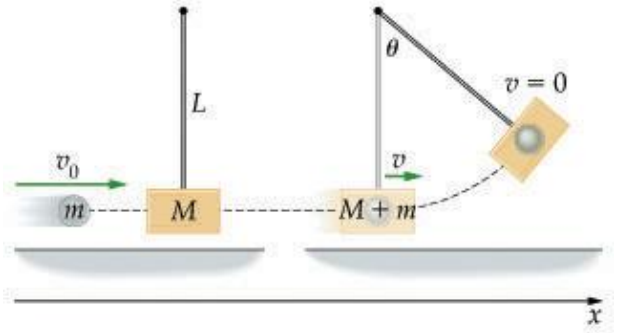
Feedback Close

You set the initial energy of the object equal to the final energy of the object and pendulum. The object collides inelastically with the pendulum, causing energy to be lost in the process. Therefore these energies are not equal.

Answer-Specific Feedback

PEARSON ALWAYS LEARNING

MasteringEngineering®



Hint 1. How to approach the problem Open

Hint 2. Determine which physical laws and principles apply Open

Which of the following physical laws or principles can best be used to analyze the collision between the object and the pendulum bob? Which can best be used to analyze the resulting swing?

- ☐ Newton's first law
- ☐ Newton's second law
- ☑ Newton's third law
- ☑ Conservation of mechanical energy
- ☐ Conservation of momentum

Try Again

submit my answers show answer review part

Feedback Close

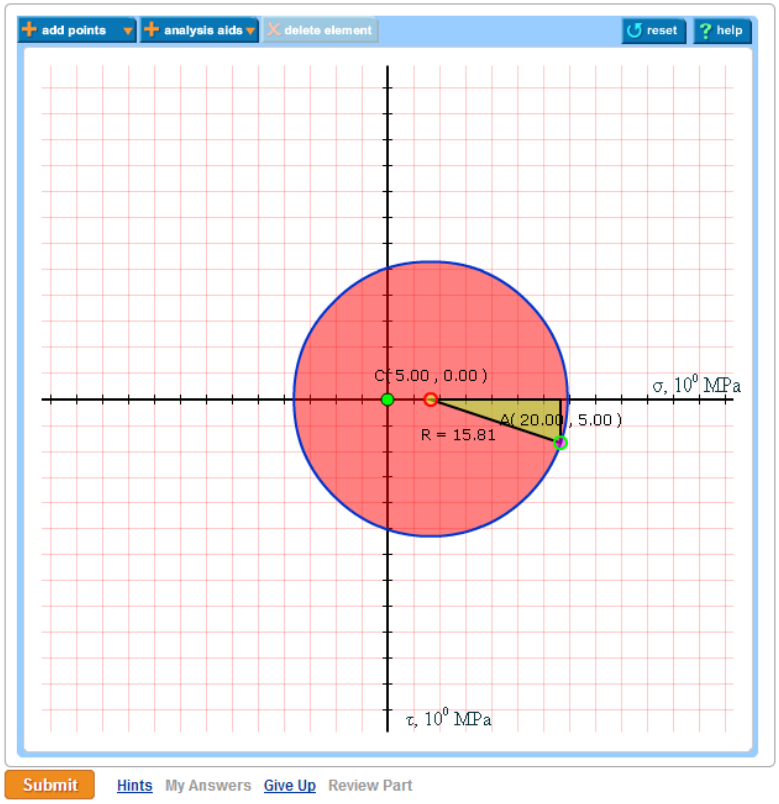
Mechanical energy is conserved in elastic collisions, but there is another conservation law that applies to any collision.

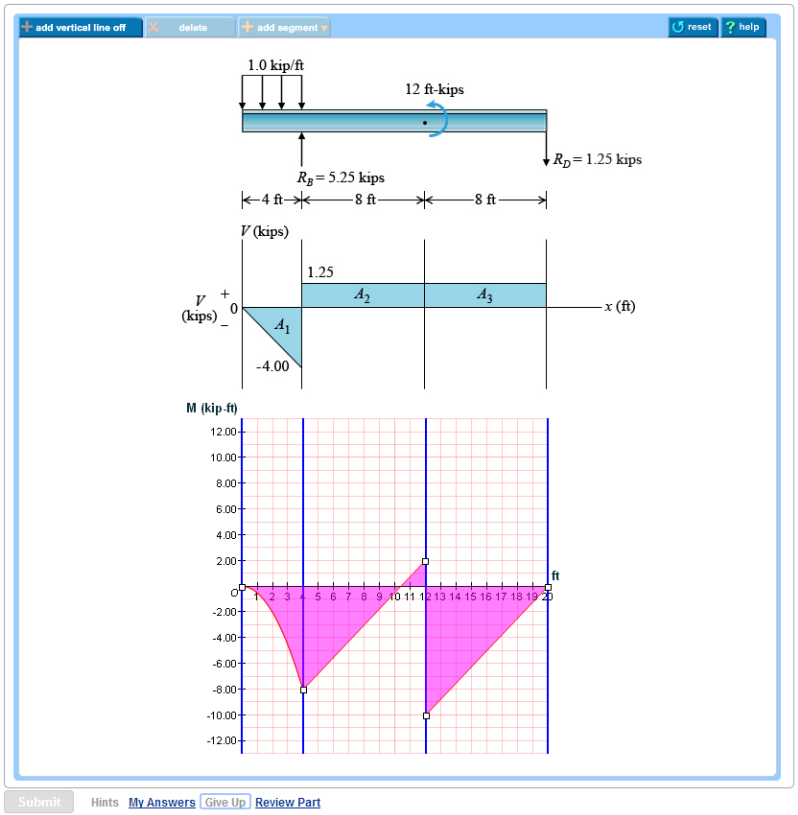
Hint 3. Describe the collision Open

Hint 4. Describe the swing Open

Socratic Hints

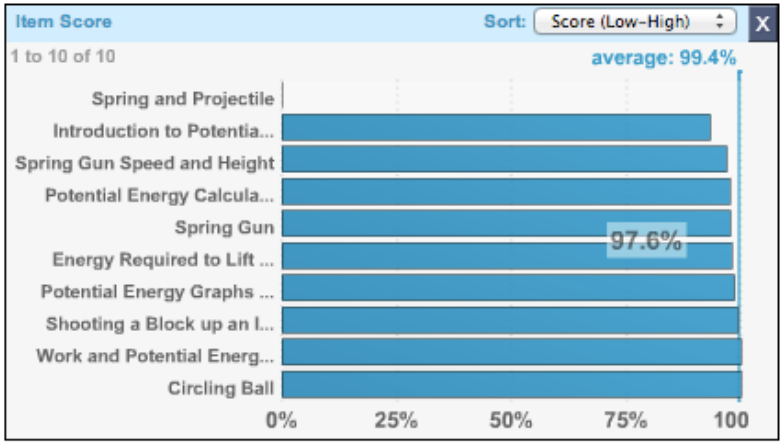
MasteringEngineering®

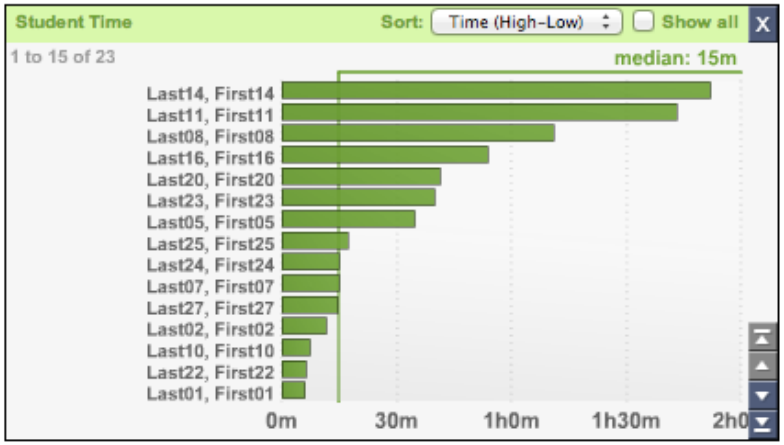




Auto-scored Answertypes

MasteringEngineering®





ANSWER: height = $\frac{H}{4}$

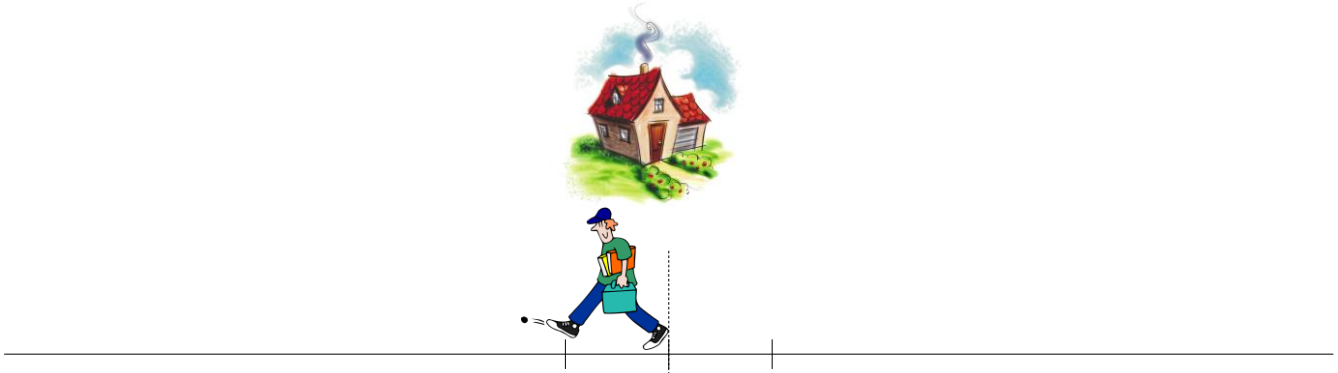
Answer Stats:	Students	% Correct	% Unfinished	% Req'd Solution	Wrong/student	Hints/student
Overall	7046	94.7%	2.8%	2.4%	0.8	0.6
MPDEMOGRADES	25	96%	4%	0%	0.8	0.2

Wrong Answers for MPDEMOGRADES

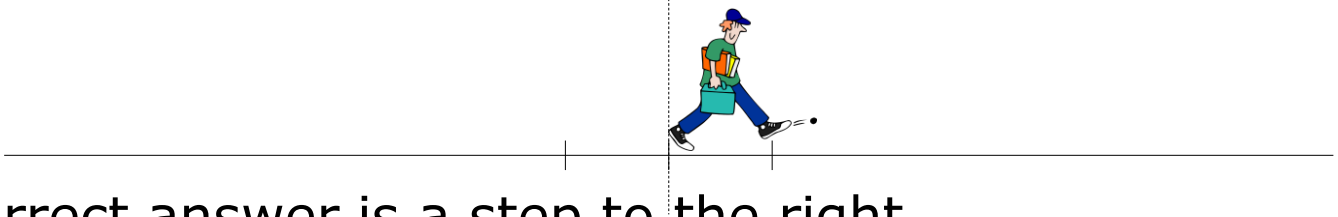
% Wrong	Answer	Response
10%	$\frac{k\left(\left(\frac{x_0}{2}\right)^2\right)}{2mg}$	The correct answer does not depend on the variables: x_0, k, m
10%	$0.5H$	Gravitational potential energy varies linearly with height, but the spring's potential energy varies quadratically with the amount of compression or extension.
5%	$\frac{.125k\,(x_0)^2}{mg}$	The correct answer does not depend on the variables and functions: x_0, k(), m
5%	$\frac{4H}{g}$	Your answer is off by a multiplicative factor.

Diagnostic Analytics

A Simple Model of Student Behavior



✗ - Incorrect answer is a step to the left

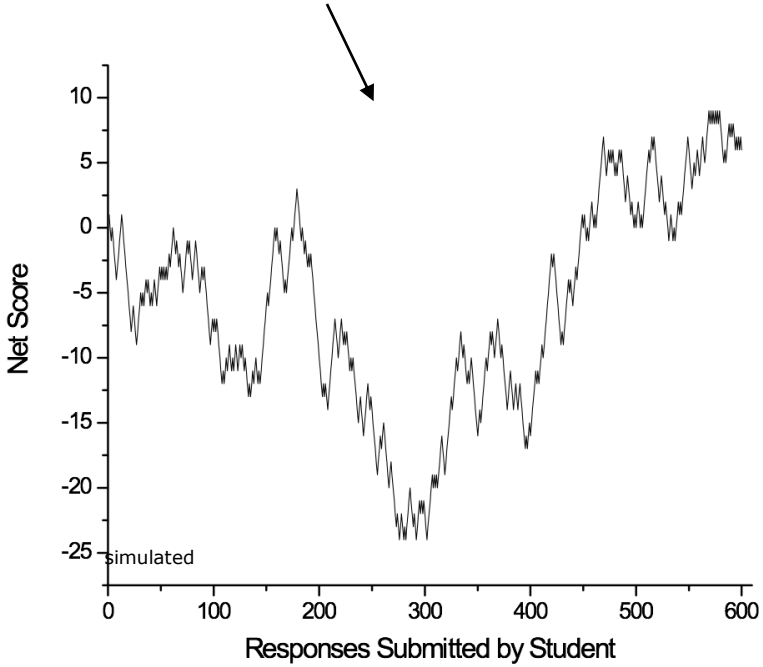


✓ - Correct answer is a step to the right

Net Score = # steps to the right – # steps to the left

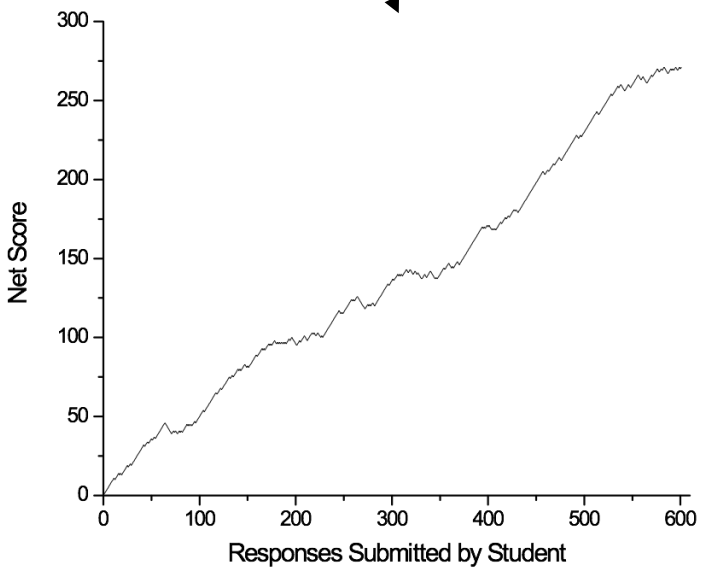
Distinguishing Response Patterns

A student showing random walk behavior



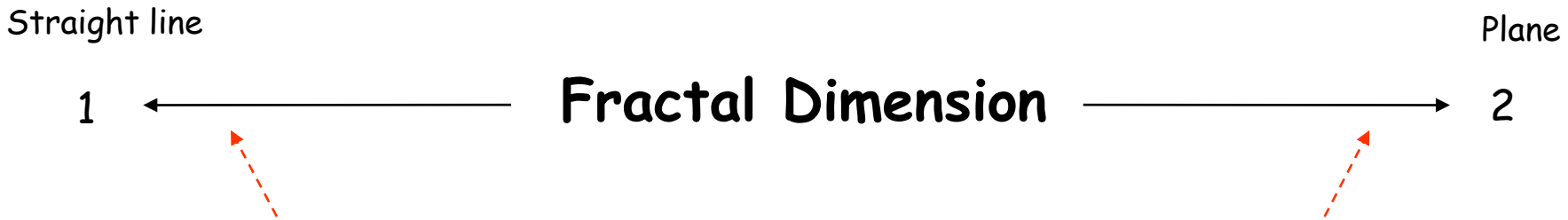
Fractal Dimension = 1.94

A student not showing random walk behavior



Fractal Dimension = 1.60

Distinguishing Response Patterns



Less irregularity in the response pattern

i.e., Persistent behavior

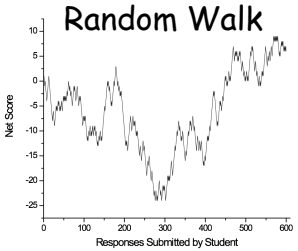
(an increase in net score at one instance is more likely to be followed by an increase at a future instance)

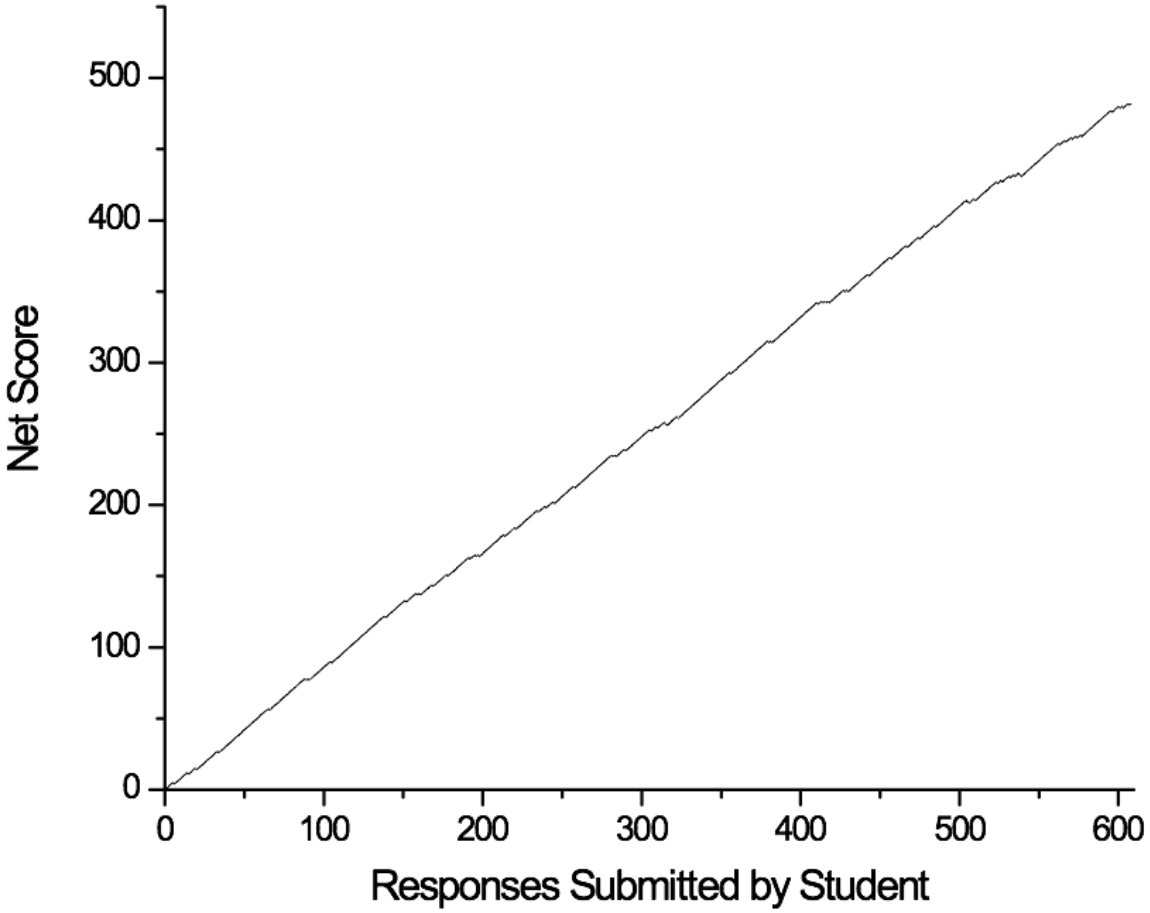
High irregularity in the response pattern

i.e., Anti-Persistent behavior

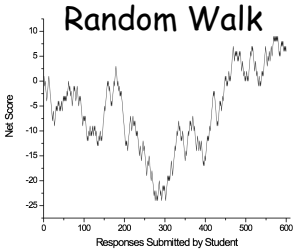
(an increase in net score at one instance is more likely to be followed by a decrease at a future instance)

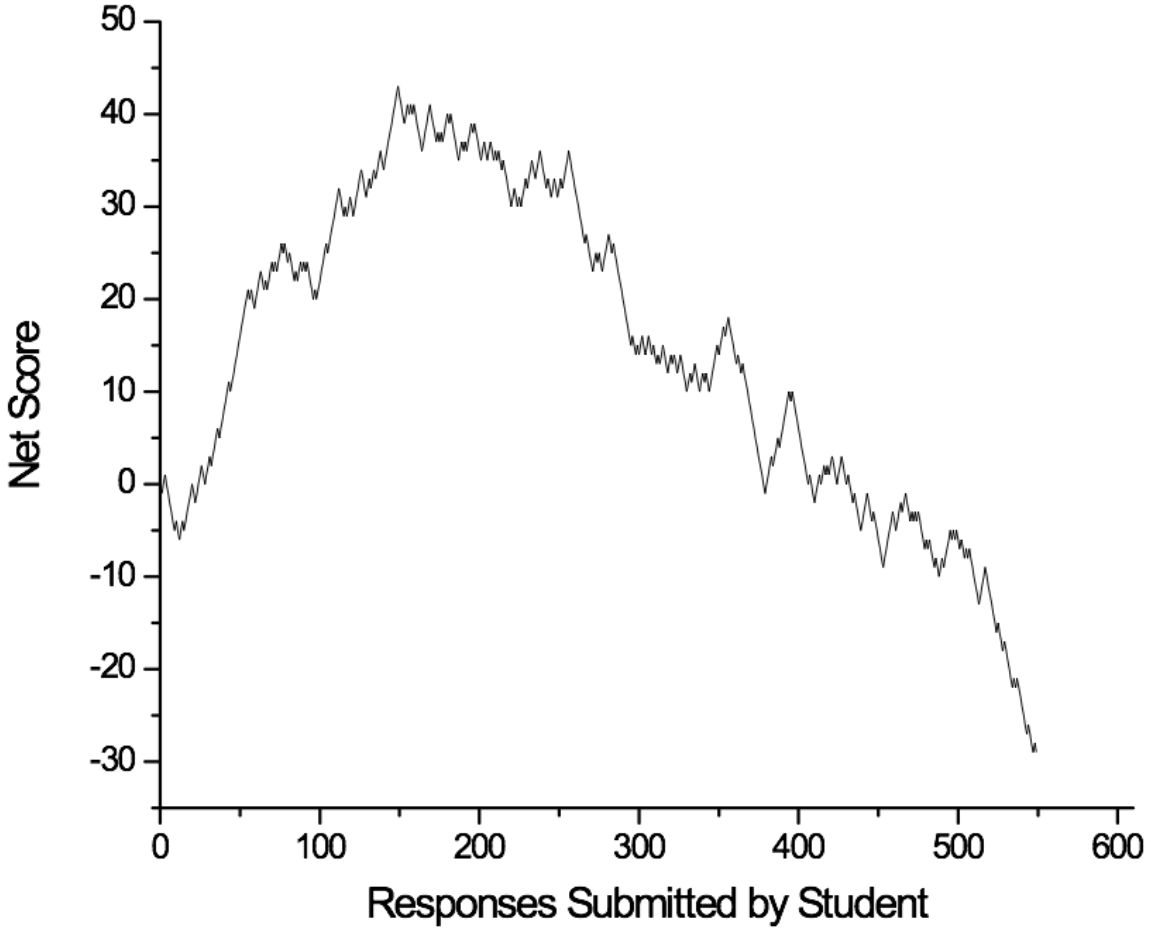
A student with fractal dimension 1.32



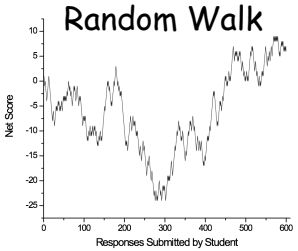


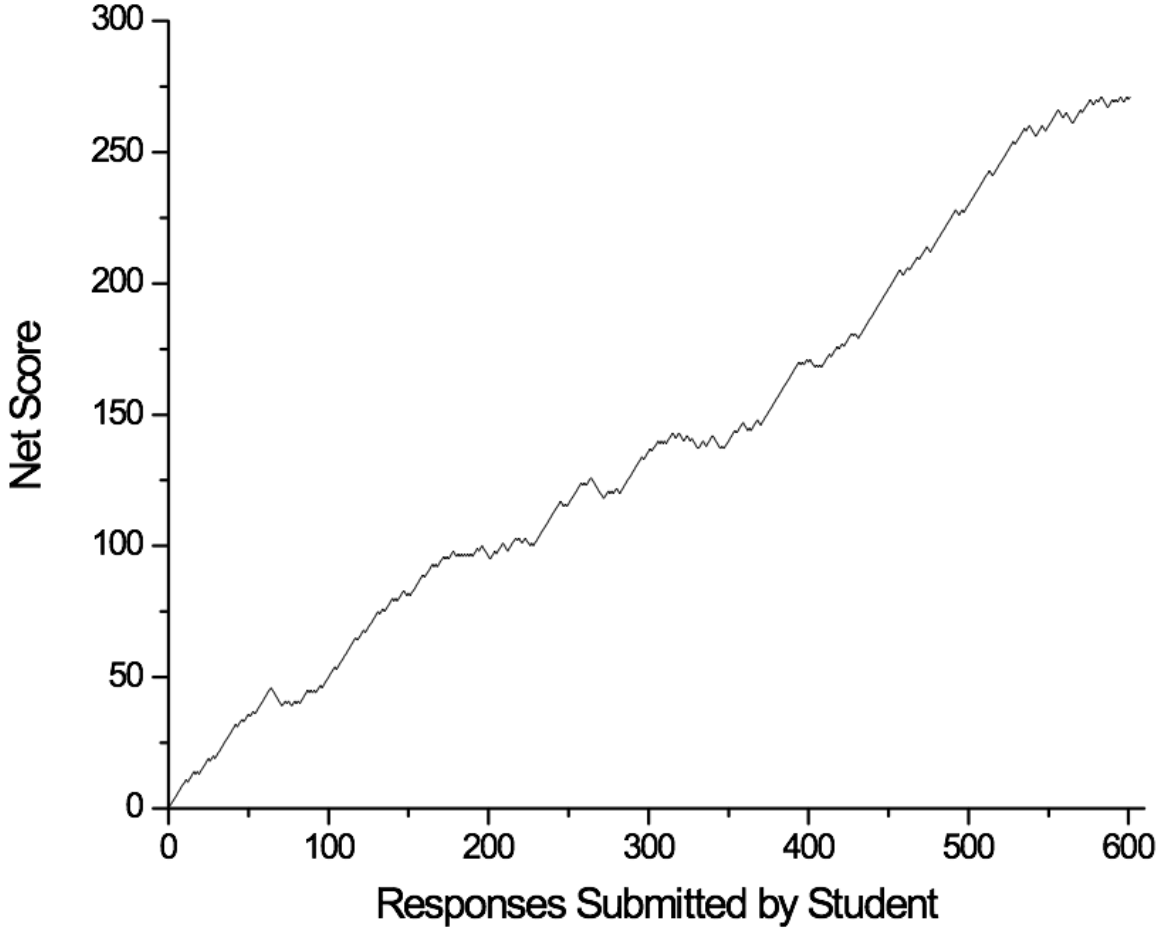
A student with fractal dimension 1.81



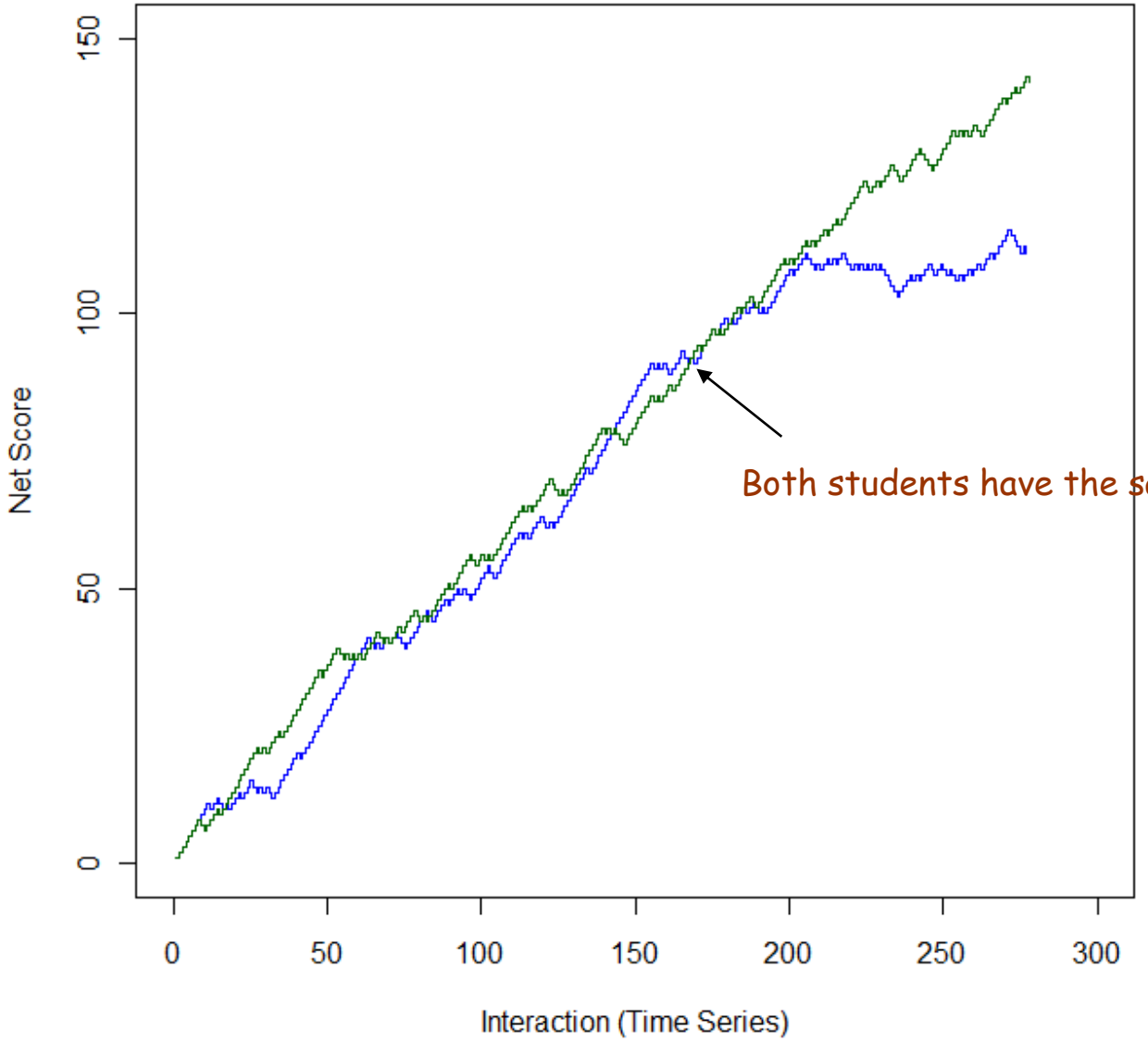


A student with fractal dimension 1.60



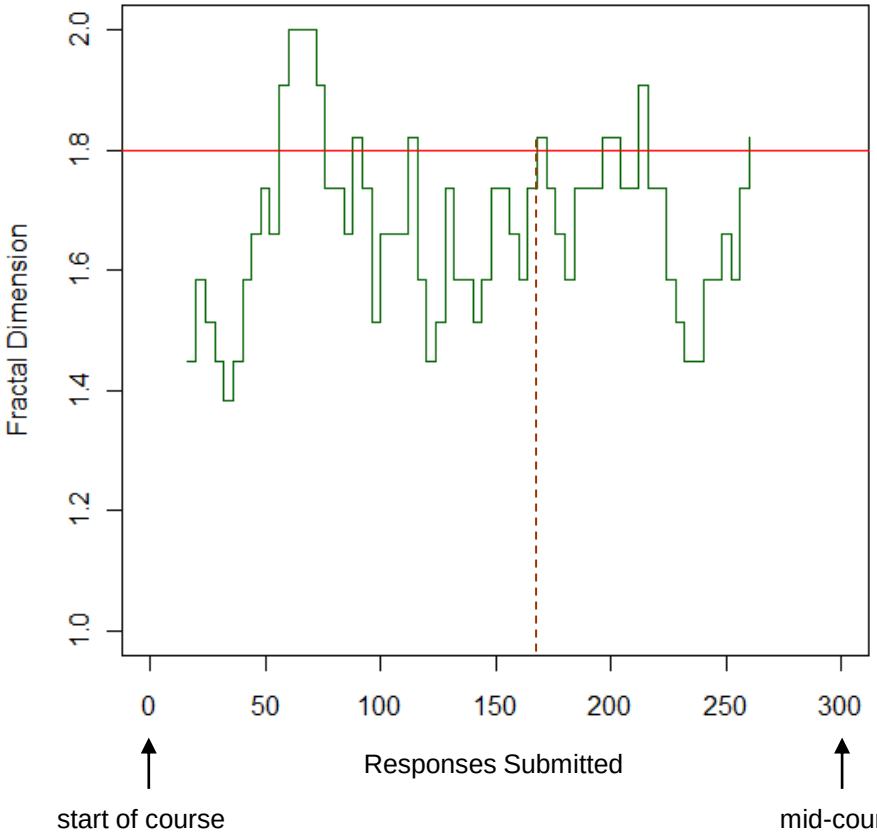


A Tale of Two Students

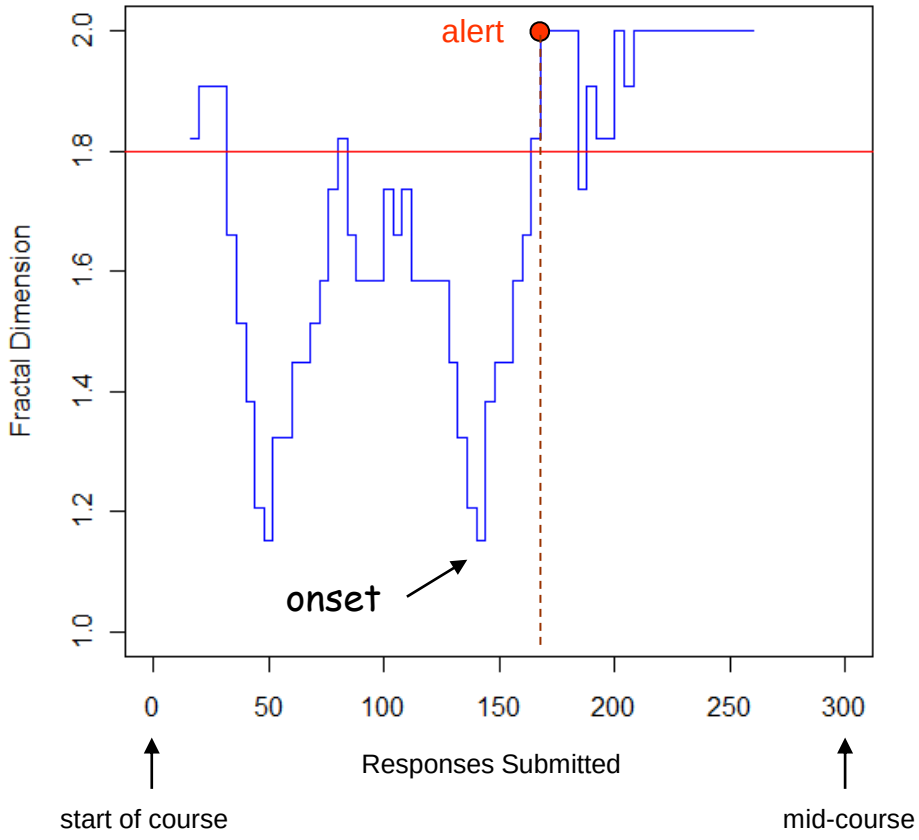


The Struggling Student can be Identifi

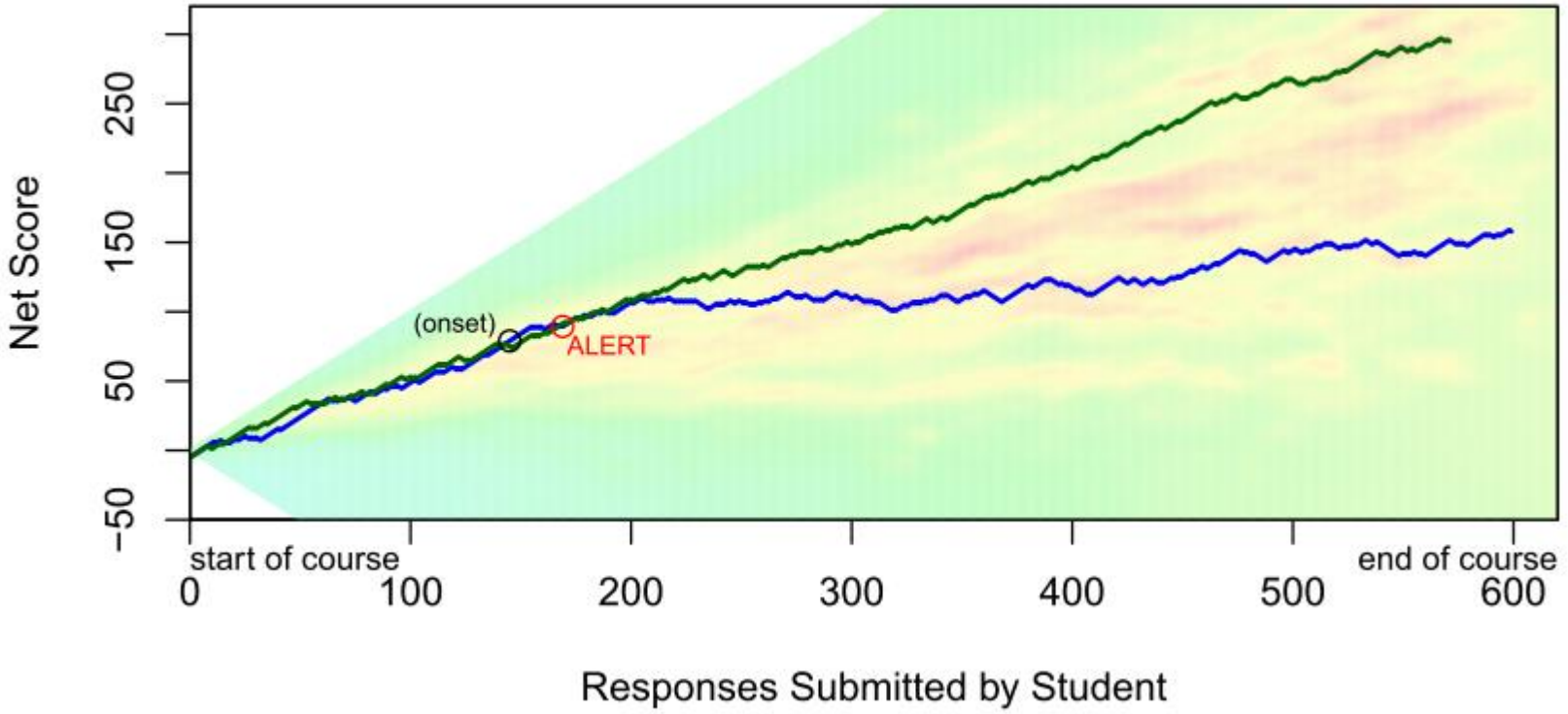
Short runs of smoothness followed by short runs of irregularity.



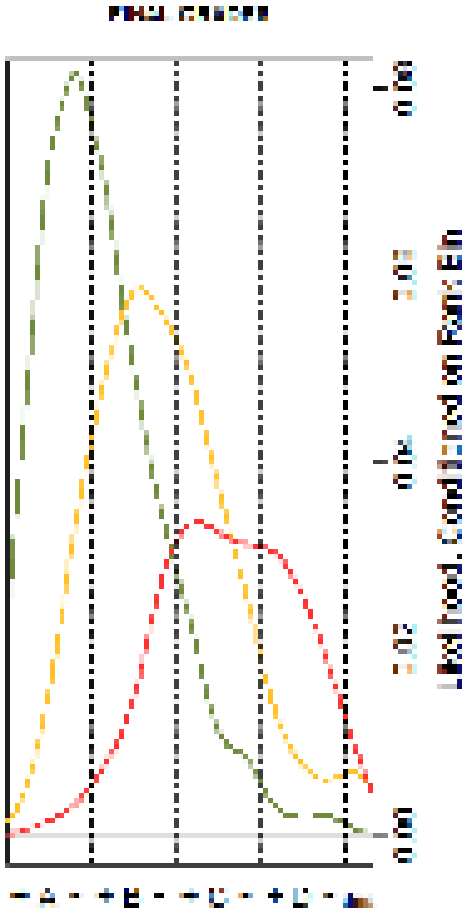
Long runs of smoothness followed by long runs of irregularity, then a tipping point (onset).



Towards Predictive Analytics

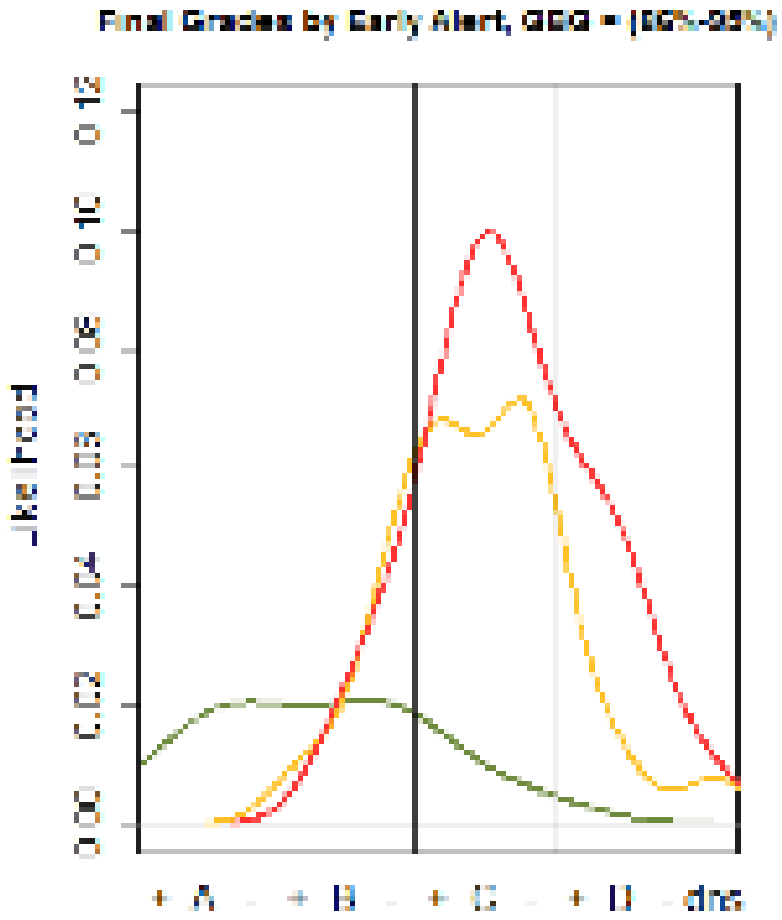


Spring 2013 Pilot — 1300 students



Low Alerts	Medium Alerts	High Alerts
88% A's and B's	77% B's & C's	73% C's & D's
<2% D+ or lower	<10% D+ or lower	~40% D+ or lower

Alerts identify previously invisible at-risk students



Despite high homework scores (86-95%), students that were identified as high alert, most often got a final course grade of C.

➔Algorithm identifies what was a previously invisible population of at-risk students.

Fall 2013 Pilot - 1500 students, 8 schoo

73% of instructors agreed alerts were **accurate**

Instructors **intervened** with students whose grades were average, but who had high alert levels — expanding office hours & reviews; adding Adaptive Follow-up assignments

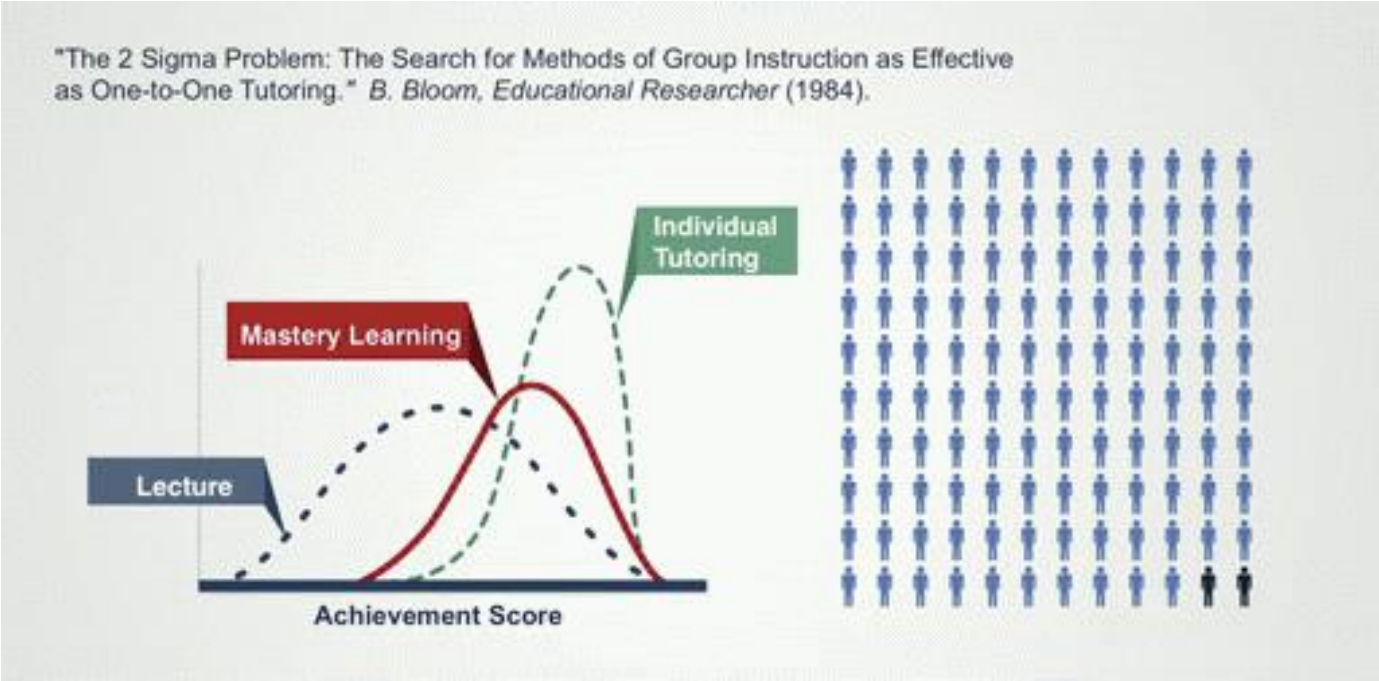
Students reported being **motivated** by the EA notification to attend office hours and reviews

A Fractal Based Decision Engine for Int

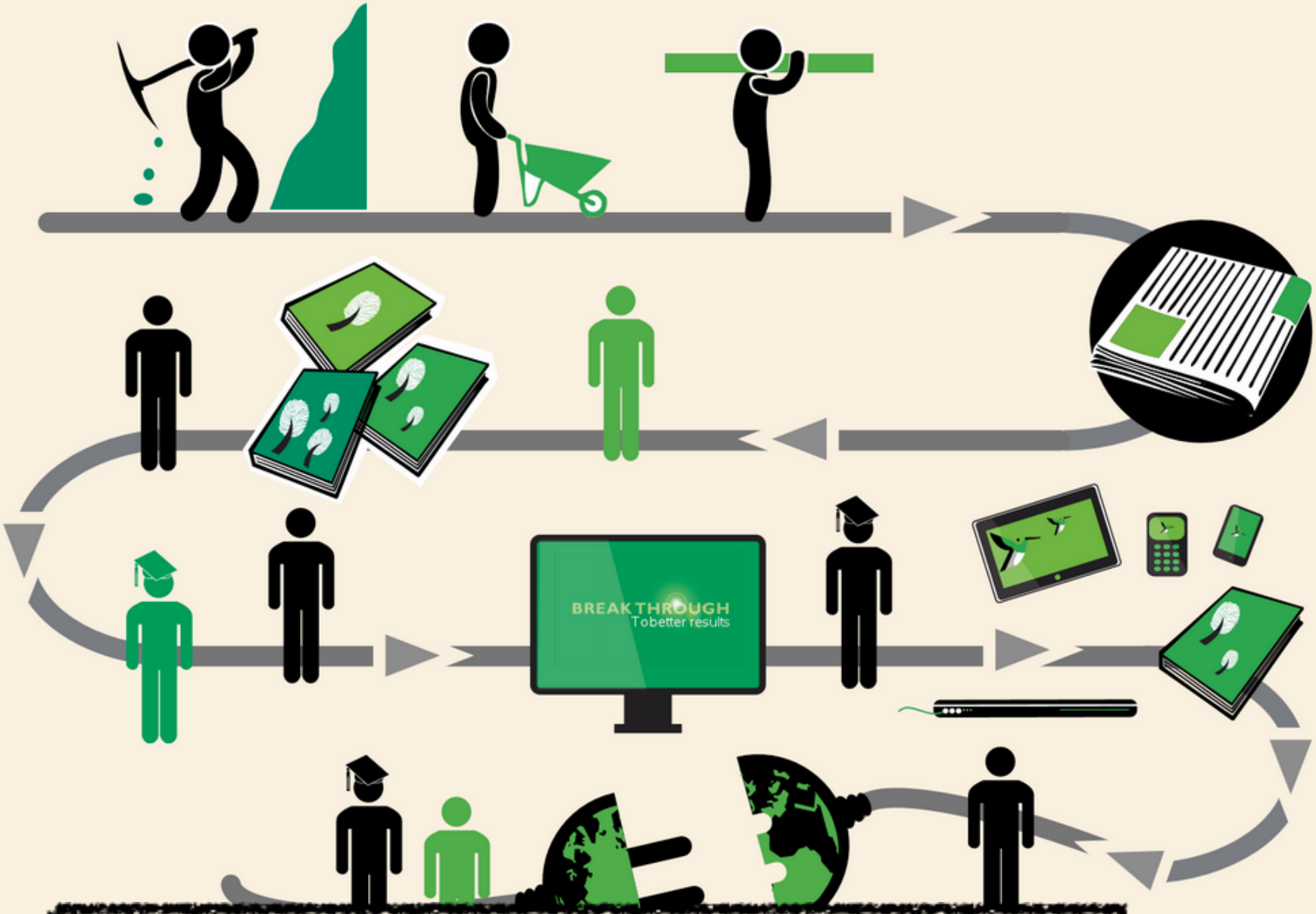
Patent Awarded: January 2014

Inventors:
Dr. William Galen
Dr. Rasil Warnakulasooriya

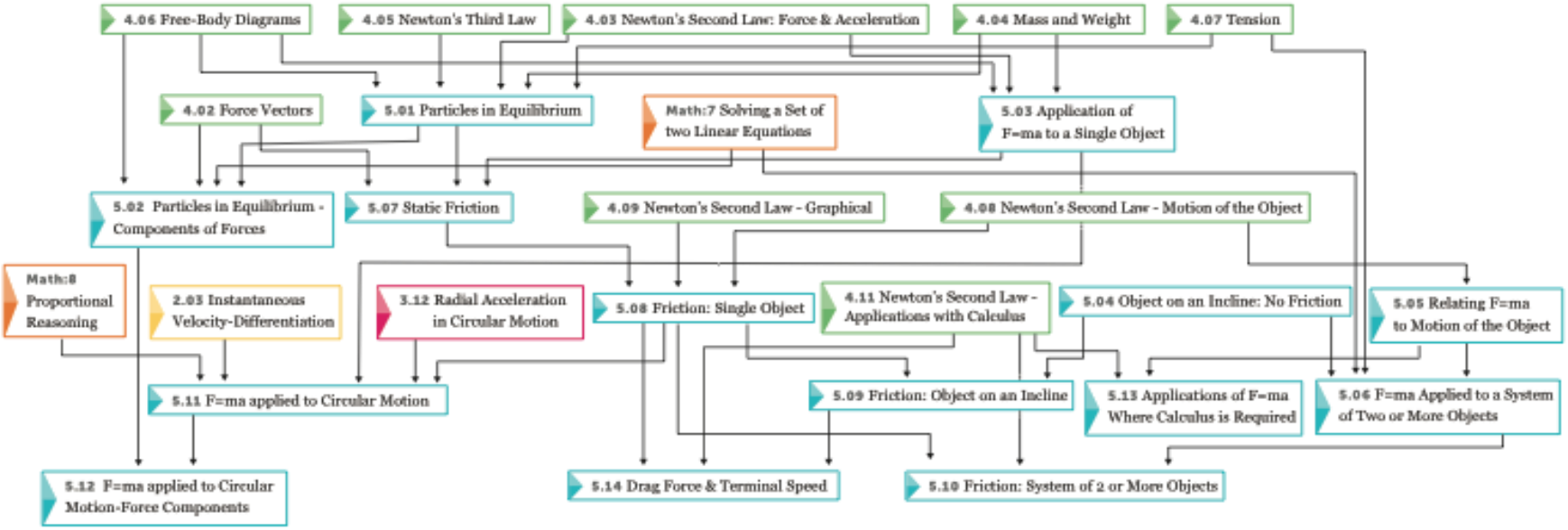
Towards a Two Sigma Solution




ALWAYS
LEARNING



NEED THIS SLIDE, OR SKIP???



NEED THIS SLIDE, OR SKIP???

Next Steps

[Or just skip to the next slide…]

NEED THIS SLIDE, OR SKIP???


ALWAYS
LEARNING

NEED THIS SLIDE, OR SKIP???