Critical Thinking Through

AMY POPE
PHYSICS AND ASTRONOMY

My students think physics is....

$$v_e = \sqrt{\frac{2GM_E}{R_E}}$$

$$T^2 = \frac{4\pi^2}{GM} R^3$$

$$x = x_o + v_o t + \frac{1}{2} a t^2$$

$$P_{gauge} = P - P_{atm}$$

$$y(x,t) = A\cos\left(\frac{2\pi x}{\lambda} - \frac{2\pi t}{T}\right)$$

$$v = -A\omega \sin(\omega t)$$

$$\theta = \theta_o + \omega_o t + \frac{1}{2}\alpha t^2$$

$$T = 2\pi\sqrt{\frac{L}{g}}$$

$$I = \Sigma m_i r_i^2$$

$$F_G = \frac{Gm_1m_2}{r^2}$$

$$U_G = -\frac{Gm_1m_2}{r}$$

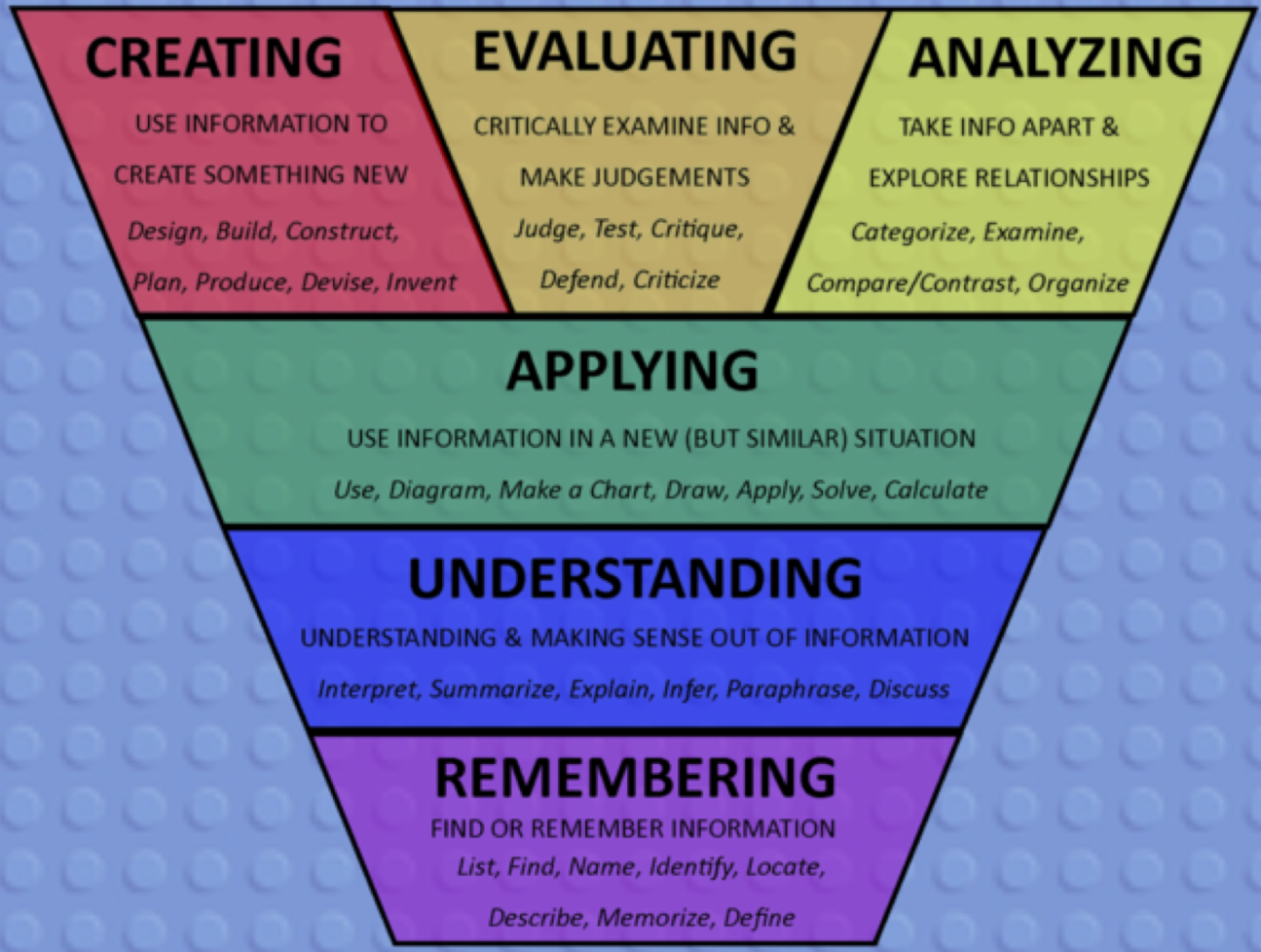
$$v = \lambda f$$

$$K_r = \frac{1}{2} I\omega^2$$

$$P_1 + \frac{1}{2}\rho v_1^2 + \rho g y_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g y_2$$

$$v^2 = v_o^2 + 2a(x - x_o)$$

But physics is so much more…



https://bokcenter.harvard.edu/taxonomies-learning

Exams:

There will be four exams during the semester and one final exam. Ea
grade with the lowest of the 5 exam grades being dropped which n
exam worth a total of 60% of your total grade. For the first exam t
have to use the missed exam as your dropped exam grade. In the ex
exam is missed, you must obtain an excuse which may be verified by
will be granted. All exams will be taken using the Respondus Lockdo
loaded through the Clemson University download page. It is the student's responsibility to ensure that the browser is working prior to taking each exam. Students who turn in a paper copy of the exam will have **5 points deducted** from their exam grade.

Class Preparation:

These assignments are indicated on the syllabus in purple and labeled as Pxx or MCS. These assignments are located through Canvas as quizzes and as Expert TA assignment. These assignments are intended to be completed after you have watched the pre-lecture video. The lowest 2 grades will be dropped.

Homework:

The 16 homework assignments are worth 20% of your course grade. Each homework is weighted the same. Homework is due at 11:59 pm on the day indicated in the schedule. Late homework can be submitted for up to 50% credit until 04/24/2019 at 11:59 pm. No homework grades are excused. All due dates are recorded on the calendar at the end of the syllabus.

To register for Expert TA, The cost is $32.50 per semester per student. Expert TA offers students the option of a 14-day free trial. Any work done during the trial, including grades received, is saved and available after the license is purchased.

Engagement:

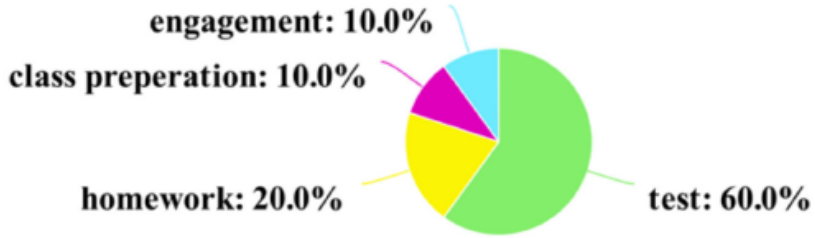
Engagement grades are worth a total of 10% of your final class grade. ***Each engagement grade is worth the same amount of credit (regardless of the number of raw points).*** Your answers will be graded 40% by correctness plus 60% for participation. Thus, an incorrect answer gets you a score of 60% while a correct answer gets you a score of 100%. No answer (an absence) gives no credit. Each day of participation is worth the same number of points regardless of how many questions are posed. Because of the pace at which material is covered and because of the cumulative nature of the principles involved it is recommended that students not miss a class unless there is a compelling reason. Students are requested to wait 10 minutes in the unlikely event that your instructor is late for class.

Determination of Final Grade:

Letter grades are awarded as shown below. Extra Credit adds for a total of 1% above your final course grade. No further changes to grades will be made after the last day of class. Grade distribution is as follows:

4 highest test grades	60%
Engagement	10%
Class Prep	10%
Homework	20%
Extra Credit	1%
Total	100%

The following scale will be used:
A: 90% or higher
B: 80% to 89.99%
C: 70% to 79.99%
D: 60% to 69.99%
F: 0-59.99%



Break it down · Make it clear · Take the guess work away

Course Schedule:

Due dates are fixed as per the schedule. On rare instances I will grant more time on an assignment if we have not yet covered the material but please consider this a fixed document of due dates.

Monday	Tuesday	Wednesday	Thursday	Friday
January 6	7 No class	8	9 Ch 16	10
13	14 Ch 16	15 P17A	16 Ch 17	17 HW 16 due
20 MLK Jr.	21 P17B CH 17	22 MCS due P18A	23 Ch 18	24 HW 17 due
27 Ptest1	28 **Review**	29 Thermometer	30 **Test 1** Ch 16-18	31 HW 18 due
February 3 P19A	4 Ch 19	5 P19B Battery	6 Ch 19	7 HW 19 due
10 P20A	11 Ch 20	12 P20B Bend Water	13 Ch20	14 HW 20 due
17 P21A	18 Ch 21	19 Ptest2	20 Ch 22	21 HW 21 due
24	25	26	27 **Test 2**	28

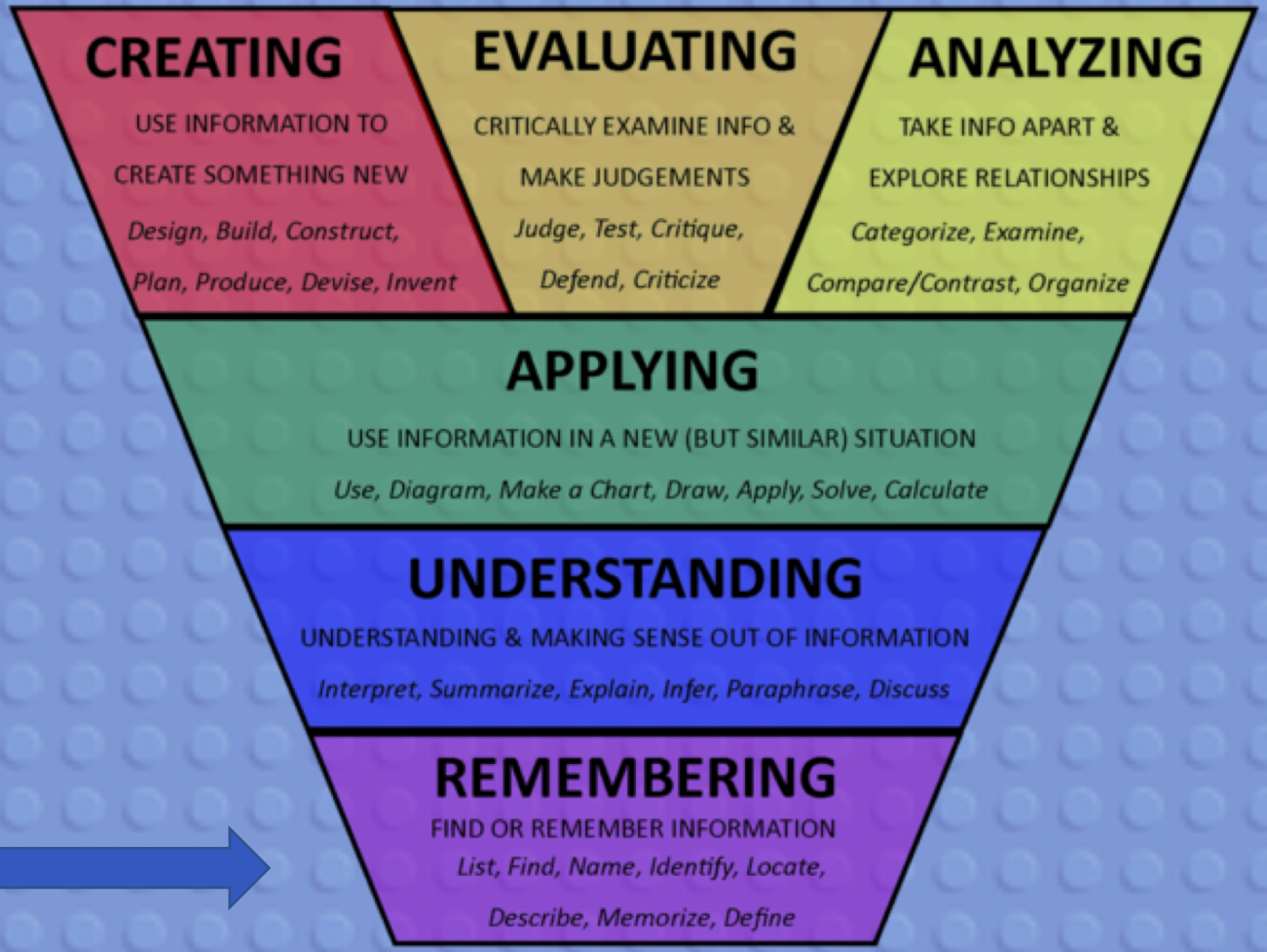
Predictable Structure · Repetition of assignment Types · Consistency of Workload

Prepare to do your BEST

- Carefully watch the pre-lecture videos prior to class and complete the class preparation quiz.
- Preview lecture notes and skim through the text for the material we will cover. Education research shows that we have to be exposed to material three times before it begins to sink in.
- Lecture notes can be printed from Canvas prior to lecture. Or annotated on your tablet.
- Engage fully in class by listening or taking notes . While playing a game or surfing the web may be fun, it does not assist in your quest for physics knowledge.
- Come to class each day with your equation sheet and calculator

- Ensure to bring a laptop or tablet or smart phone with ExpertTA to participate in the class engagement activities.
- Watch recorded lectures of the course if you wish to review or are still unclear about a concept.
- Really DO the homework. Rely on your brain not the internet.
- Study often and in small spurts. The concepts in this course build on one another. Studying little by little will overall reduce your study time and result in improved grades.

Office Hour Hints · How I would Study



Structure frees up mental room for course content.

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So where does

Creativity

fit in?

COVID has made boundaries and structure and CREATIVITY even more important.

- Personalized emails.
- Pacing guides with best practices included.

Assignments DUE this week:

09/01/2020	R4 – Topic 15	location: Modules/Recitation
09/02/2020	Extra Credit Straw	location: Modules/Extra Credit/Long Straw (OPTIONAL)
09/03/2020	R5 – Topic 15	location: Modules/Recitation
09/04/2020	HW15 due	location: Modules/Module 1/Concept 15 Homework

Best Practices for this week: Suggested Pacing

Below is a suggested guide of how to use your time. The only items that are graded are shown above. Please note that you must complete both recitation assignments (R4 and R5).

8/231/2020	Watch Lectures: Concept 15 through Worksheet 15: Section A Answers (3 videos total) Note: worksheets are not for a grade, just for your practice ~ 1 hour to complete…be sure to take notes	location: Modules/Module 1/Module 1 Worksheets& Lectures: Concept 15
09/01/2020	Recording of Zoom meeting can be accessed after 2 pm. This recording is of one recitation session that was run earlier this morning…the content is unique from Thursday's recitation. R4 – Topic 15 due	R4 location: Modules/Recitation
09/02/2020	Watch Lectures: Concept 15 Fluids: Bed of Nails to the last video (6 videos total)	location: Modules/Module 1/Module 1 Worksheets&

COVID has made boundaries and structure and CREATIVITY even more important.

- Personalized emails.
- Pacing guides with best practices included.
- Discussion boards to post questions to discuss.
- Emails or announcements to go over the finer points of class.
- Many low-stakes assessments.

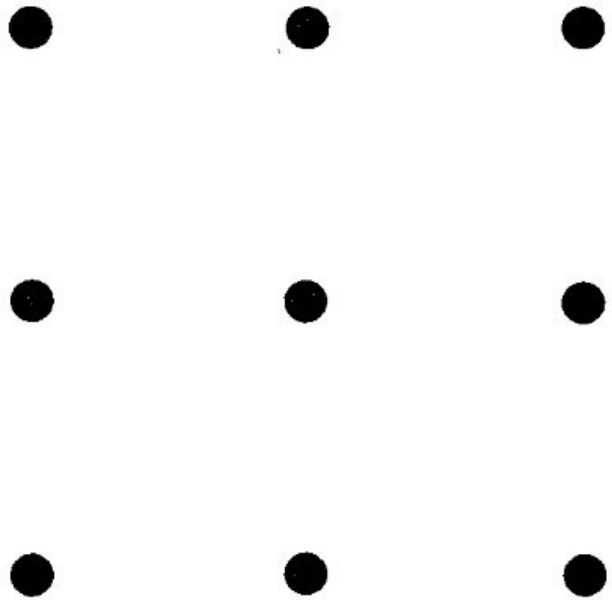
Covid has changed student mentality.

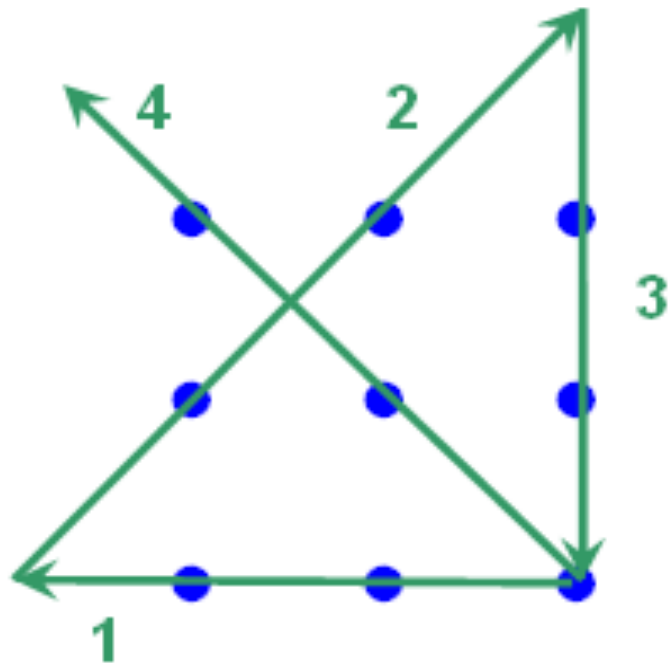
- Today's students are quite adept at finding resource or solution on the internet (Chegg, Discord, GroupMe).
- Education must move beyond textbook exercises and rote memorization (this can all be found online), toward critical thinking and analysis.
- As instructors we must provide an educational environment that
  - Allows students to find the answer – not just give the right answer
  - Pushes them to analyze scenarios
  - Compels them to reason through possible solutions

How can we do this? We must think outside of the box.

We can explain a concept to students or we can wait for them to arrive at the conclusion on their own…with a bit of creativity and guidance.

Connect the dots with no more than 4 straight lines without lifting your hand from the paper.





That was fun…

You learned to think outside of the box.

What do the students need/want?

- The experience should be meaningful or build practical skills.
  I need to teach them content.
  Students want impact on their major or life.

- Desire authentic connection not just book knowledge (which they can google).

Today's students are the first to jump on a challenge. They want to post themselves portrayed in some novel way on TikTok or Snapchat.

Interaction with Real Life.

We will use Scooby and the gang to quickly assess our thinking.

Fred, Velma and Daphne use critical thinking to evaluate the problem. They arrive at a conclusion about the ghost based on reasoning and deduction. We will work through problems in this class evaluating our interpretation of our world on first blush and then through critical reasoning.

Real Life

Assuming the period is ?, Determine the length of the rope these men are using.

a. Impossible to determine
b. 2m
c. 3m
d. 4m
e. 6m

$$T = 2\pi\sqrt{\frac{L}{g}}$$

$$L = \left(\frac{T}{2\pi}\right)^2 g$$

Roxy proposes that the period of the swing should be changing as more guys pile onto the swing. If her assertion is true, it is because the effective length of the string is _____ and the period is subsequently _____.

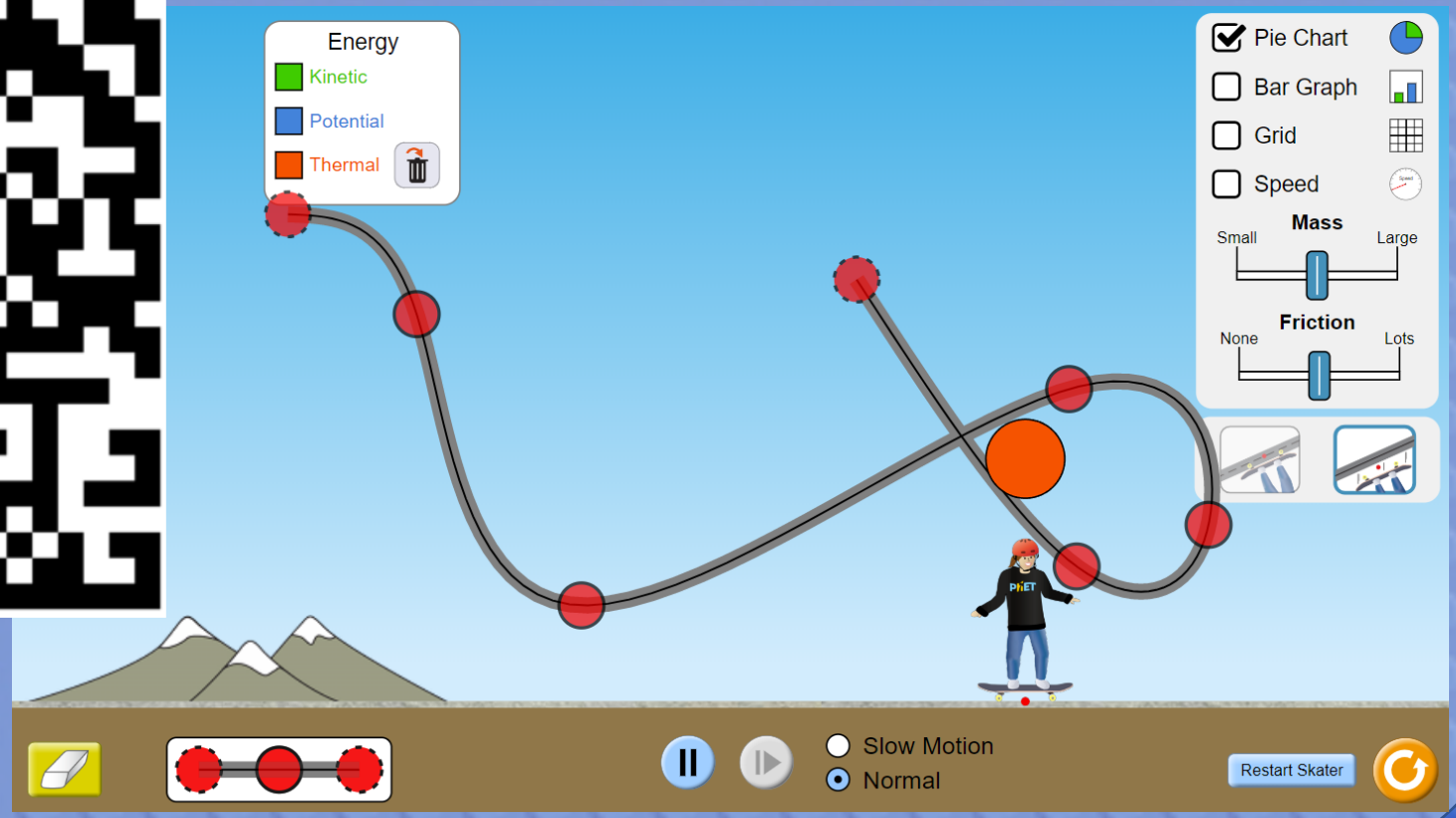
a. increasing, increasing
b. increasing, decreasing
c. decreasing, increasing
d. decreasing, decreasing

D

$$T = 2\pi\sqrt{\frac{L}{g}}$$

Interaction with real life???

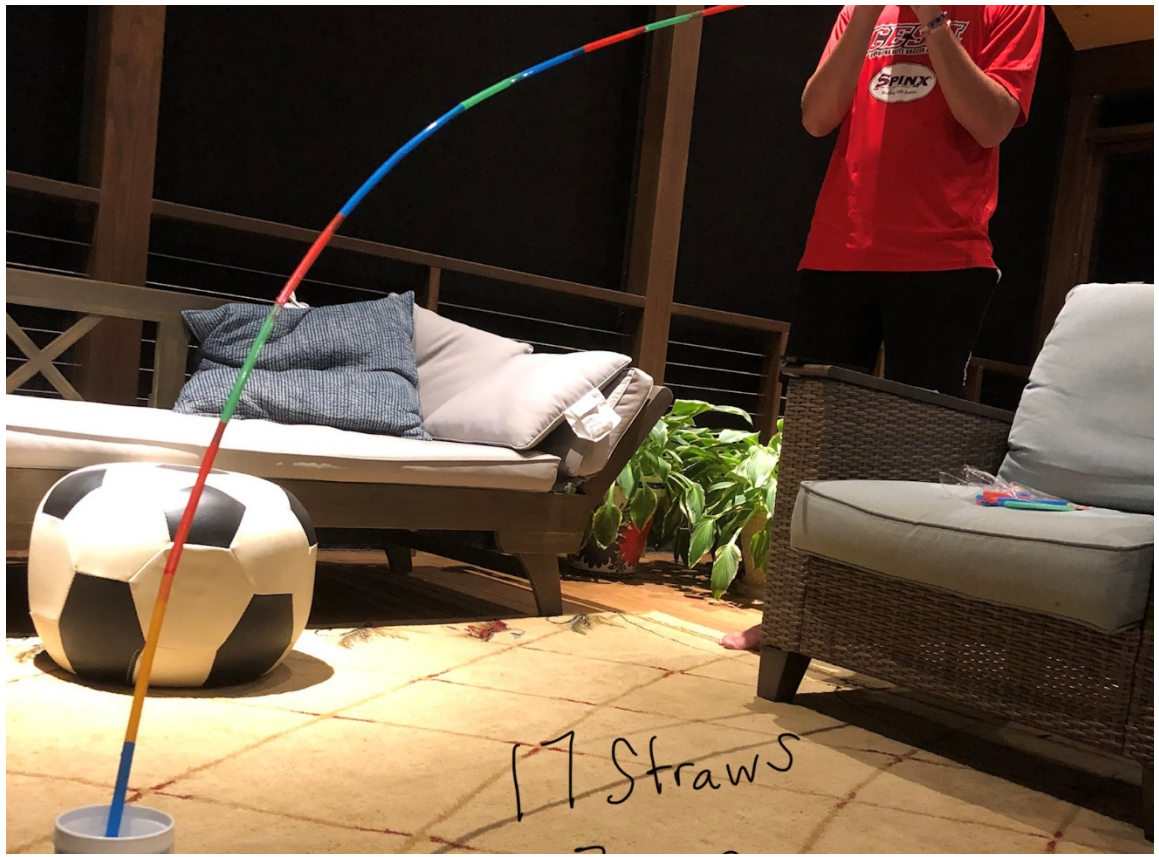
Put the students in control by allowing them to link out to interactive sites.



Today's students are the first to jump on a challenge. They want to post themselves portrayed in some novel way on TikTok or Snapchat.

Interaction with Real Life.

Extra credit activities.



$3.23\ m$


10ft 3 inches


I was able to reach 30ft.


7'3"!
(My "straw" is plastic tubing that will be installed as a waterline under the house my dad is renovating)
The rooftop was a little too high up

Today's students are the first to jump on a challenge. They want to post themselves portrayed in some novel way on TikTok or Snapchat.

Interaction with Real Life.

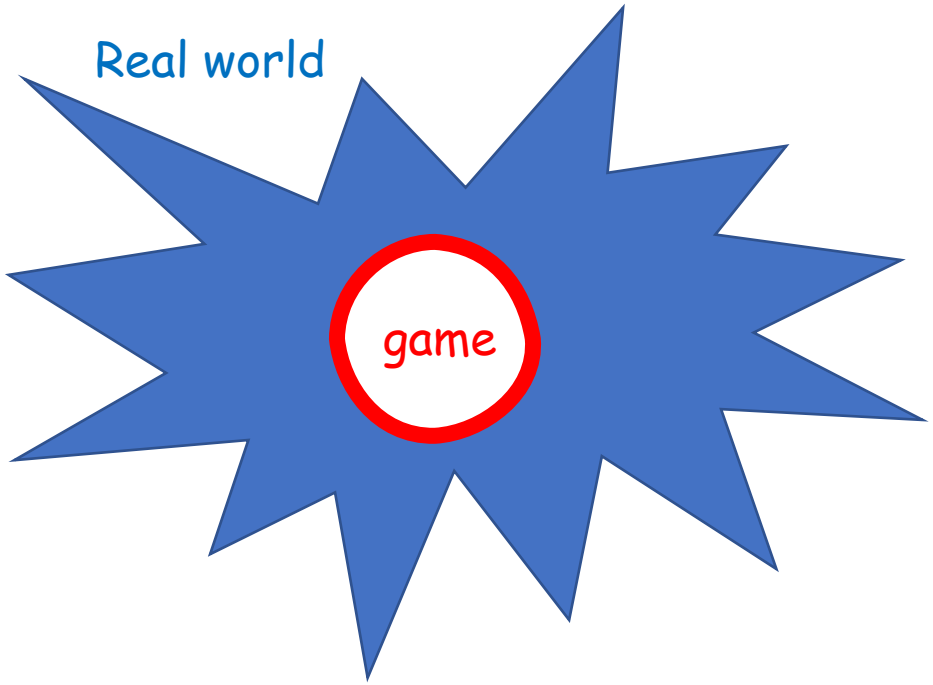
Extra credit activities.

In class games.

Is play for serious scholars?

Newton was at play in his mind when he saw the apple tree and conceived the force of gravity.

Watson and Crick were playing with possible shapes of DNA molecules when they stumbled upon the double helix.



When you are in the magic circle, the rules of the game matter more than the rules of the real world.

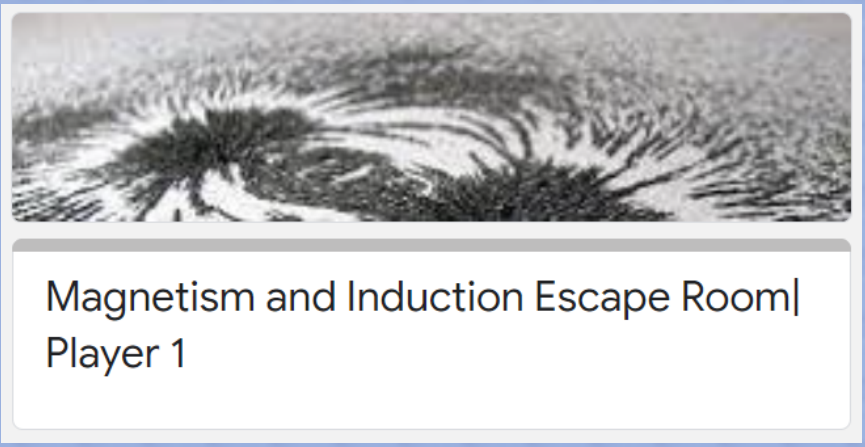
Gamification involves elements of games so we need to put the player as much as possible in the magic circle.

How Many Combinations Are Possible Using 6 LEGO Bricks?

Mathematician Søren Eilers wrote a computer program modeling all the possible brick combinations:

915,103,765 combinations

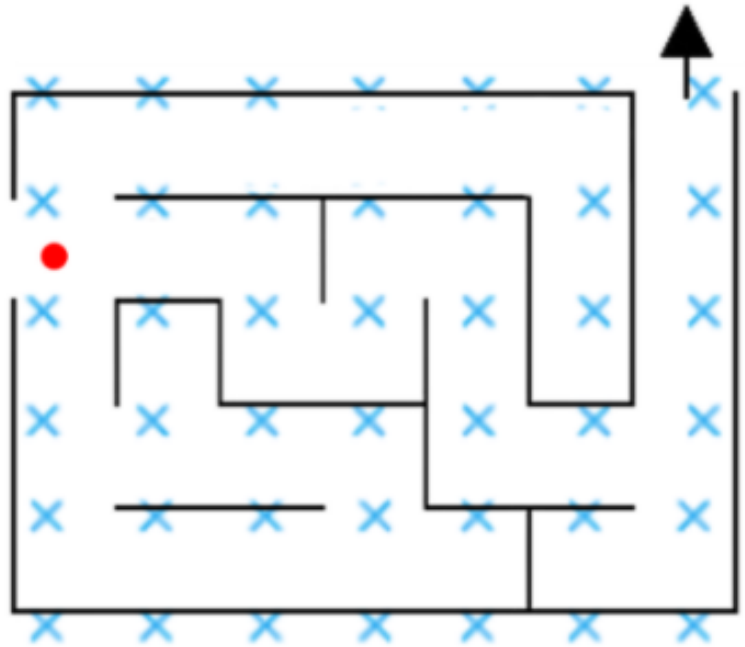
Right hand rules in physics are
HARD
…but then add zoom…

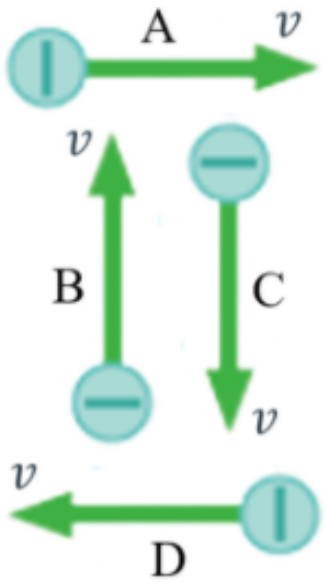


Traditional questions are presented with a gaming flair

- 4 players and all have unique clues.
- All clues are necessary to solve the problem and progress through the next door

Clue 1: Place the appropriate charge A, B, C, or D at the red dot in the blue magnetic field to move it through the maze in the most direct path. *



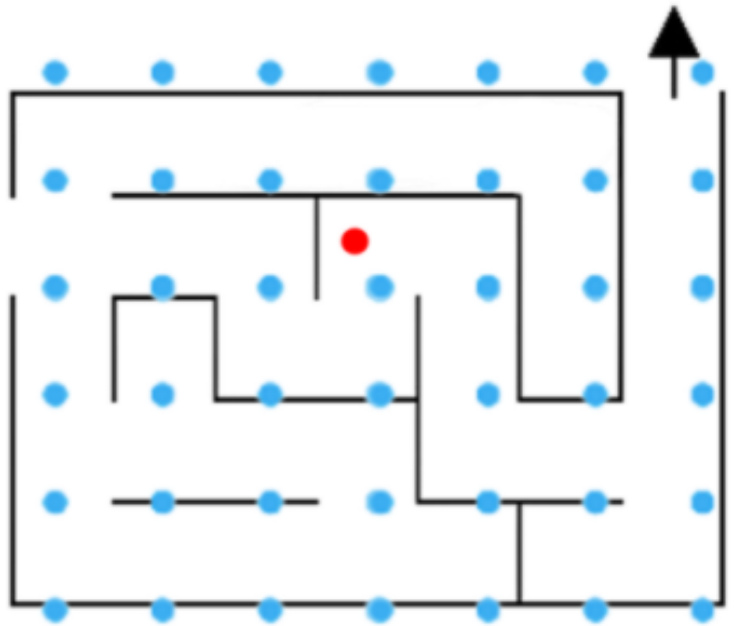


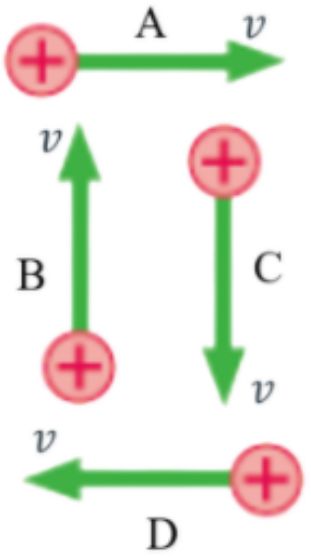
Find your way through the maze
Join us in this latest craze
The magnetic field is large
You must steer the charge

Google forms!

Allows feedback without penalty.

Clue 5: Place the appropriate charge A, B, C, or D at the red dot in the blue magnetic field to move it through the maze in the most direct path. *



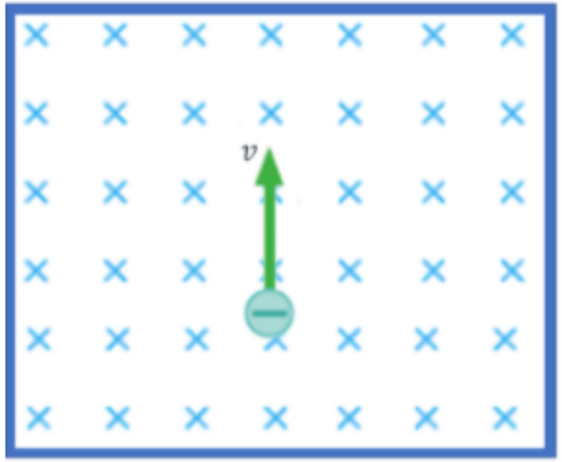


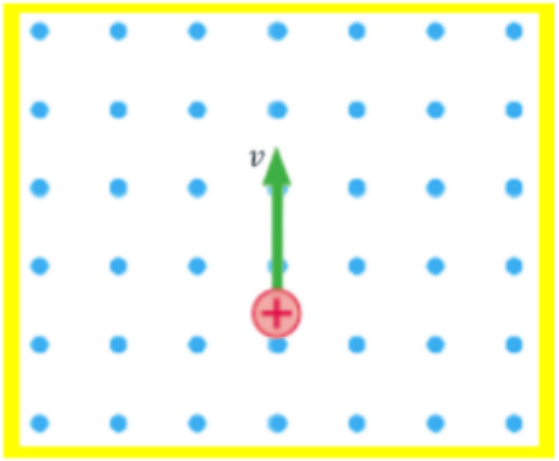
A

Use the RHR: open hand, thumb along v, fingers in the direction of magnetic field, force comes out of the palm.

Up, down, left, right
Determine the direction I invite.
A charged particle moves within a magnetic field
What electric field will the magnetic field yield?
The relationship between magnetic fields, electric fields and velocity
Will help find their colors as you work with reciprocity.

A charged particle moves with a given speed in a magnetic field (indicated in blue). In which direction is the electric field pointing? Up (U), Down(D), Left (L), Right (R)

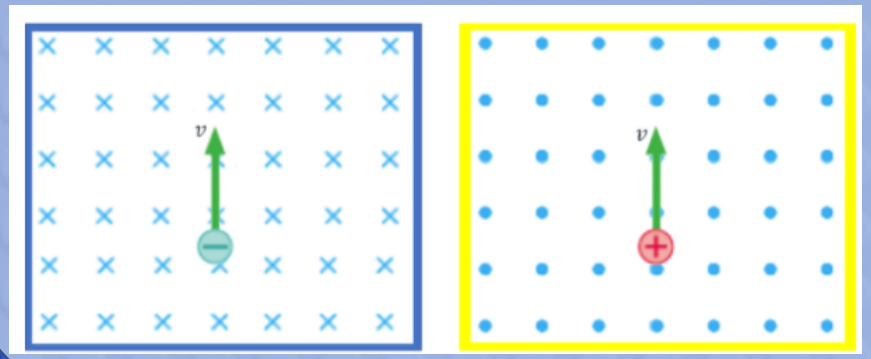




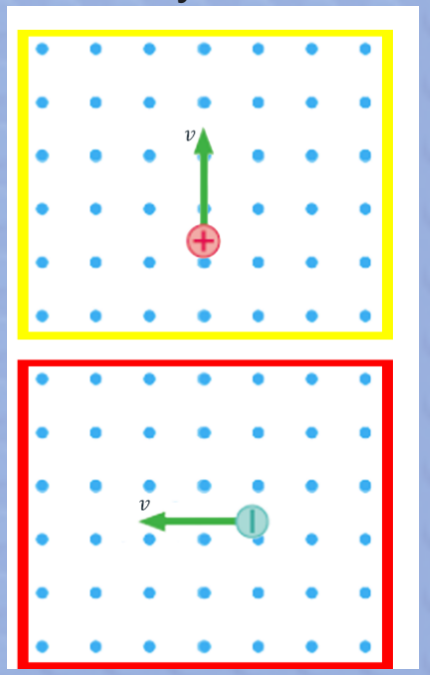
The code is 4-letters: *

- Overlap in clues allows students to "check" the answers.
- No one player can do it alone!
- Peer to peer teaching.
- ALL players must be active learners.

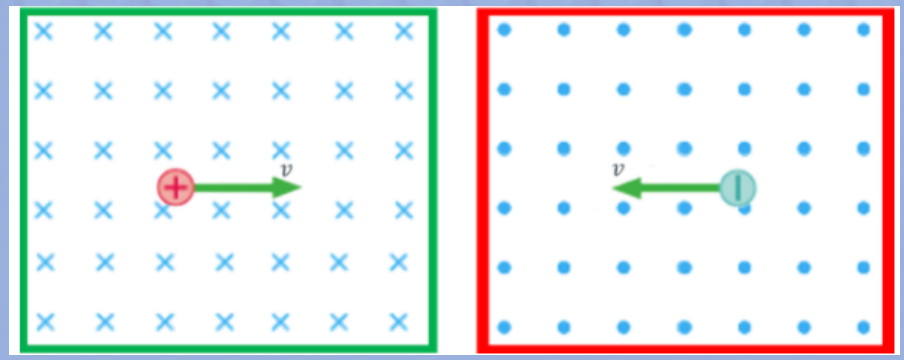
Player 1



Player 2



Player 4



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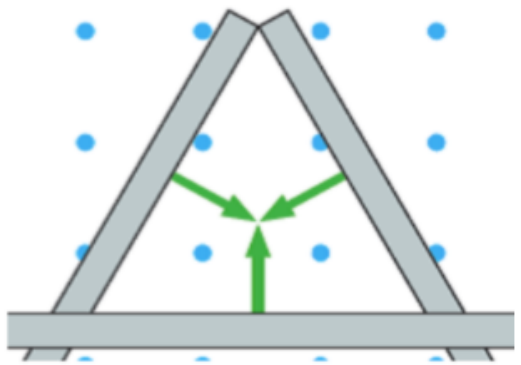
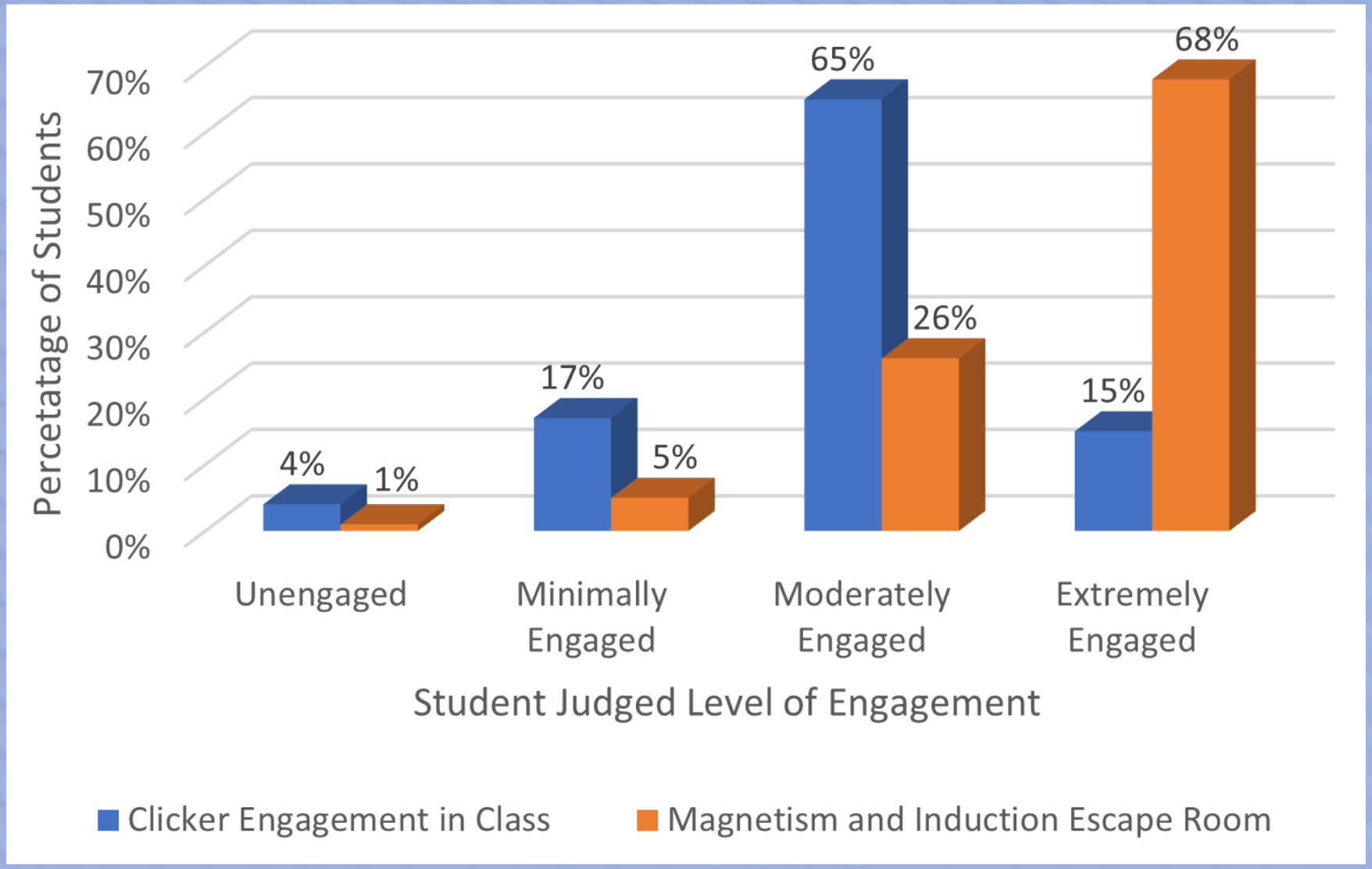


Use the pattern below to determine the combination of the lock. The padlocks you solved (red, blue and purple) will tell you to turn CW or CCW and the puzzle x, y, or z will tell you how far to turn. Your answer will be of the form: 15 CW 4 CCW 6 CCW. The combination for the vault lock is: *

x  y  z 

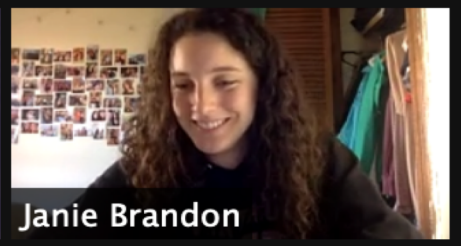


Students self-reported their level of engagement in the escape room activity as compared to the use of clickers in the classroom.

- Escape rooms worked for in person groups as well as zoom breakout rooms.
- The students were so engaged, few noticed I was there!


Julia Thees


Michael Gadelrab


Janie Brandon


I ESCAPED
from Dr. Pope!!!
Magnetism
Inductance
Desmond Brunson

What Students Thought

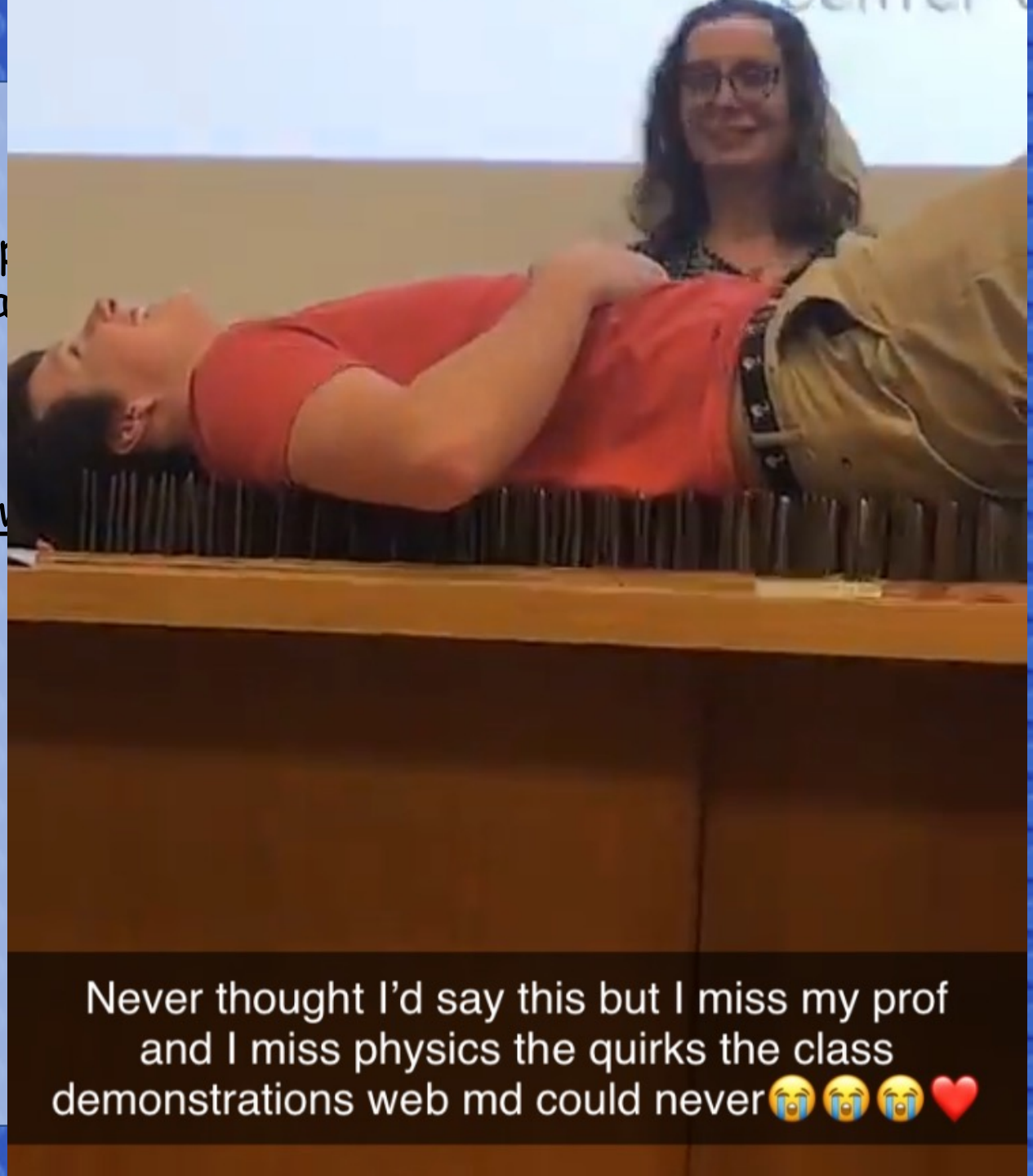
I think this required some critical problem solving and teamwork. It was helpful to have people explain things that I did not understand.

This activity was engaging and, therefore, allowed me to retain more of the core essential information needed for all concepts in this chapter and on the upcoming exam. It was also a ton of fun which will make the memory of this activity and the lessons learned stay in my brain longer!

I liked the escape room a lot because you could move at your own pace. I also like how you must really understand the problem/find the right answer before you advance.

I think it was less stressful because it was not a grade based on if you got it correct the first time, but were you able to adjust and work through it. I enjoyed having the option to ask for help from peers and learn tips and tricks from them.

•Today's students are the first to jump
themselves portrayed in some novel wa
Interaction with Real Life.
Extra credit activities.
In class games.
Demonstrations they can interact w



So how do you grade this?

Grades "play to extrinsic (not intrinsic) motivation, decrease enjoyment of learning, and increase fears of failure." (Flaherty) .

- Labor based grading
  - Did you do it?
  - How hard did you work?
  - Did you learn?
- Metacognitive feedback assignment in Canvas.
  - Focus on what students learned.
  - Students reflect as to what skills were developed.
- Full credit for a credible attempt.

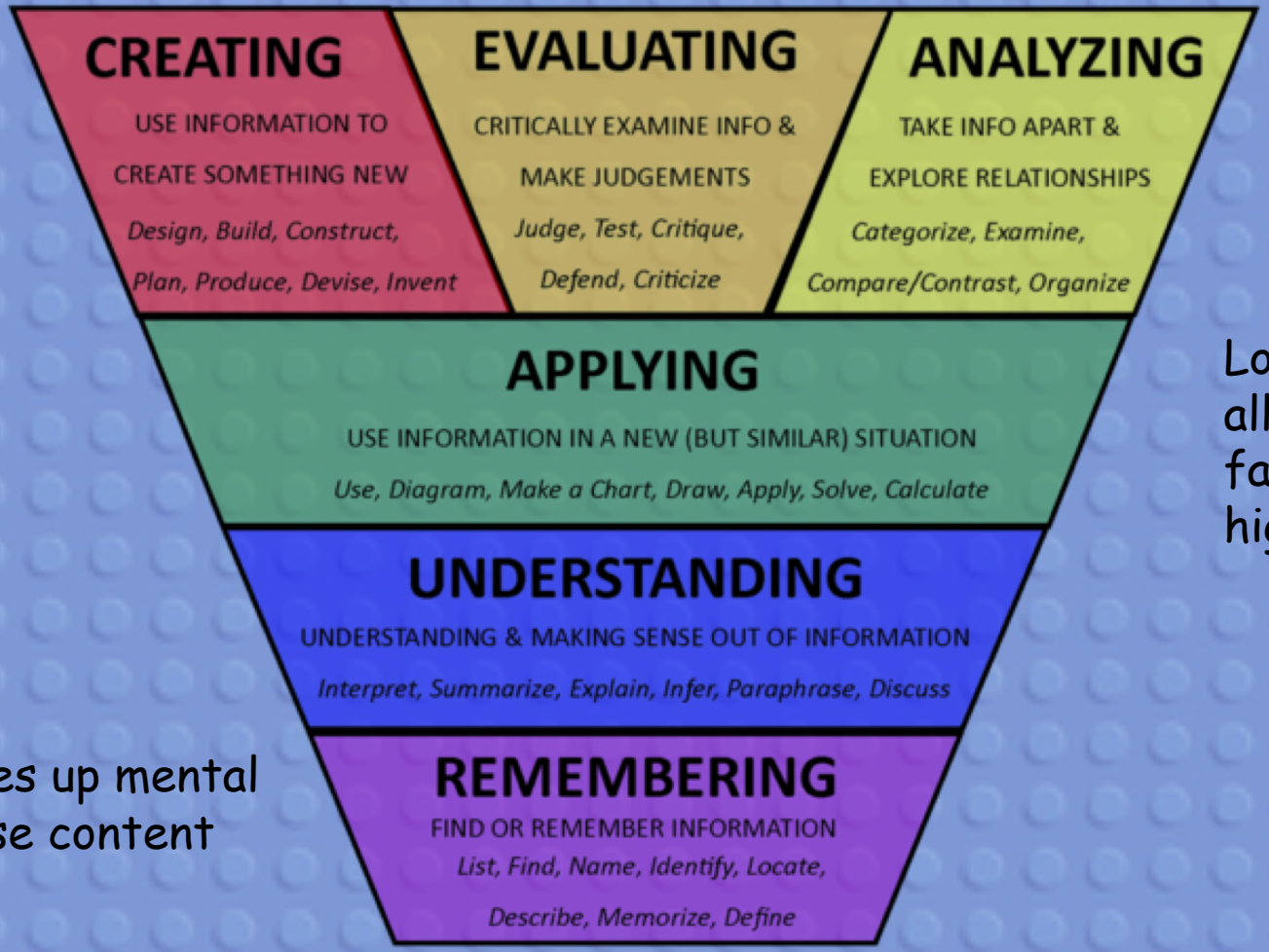
Flaherty, Colleen. "When Grading Less Is More." (https://www.insidehighered.com/news/2019/04/02/professors-reflections-their-experiences-ungradingspark-renewed-interest-student)

Extra Credit

TikTok

In-Class Experiments

Escape Room



Low stakes assessments allow for freedom of failure while trying higher order thinking.

Structure frees up mental room for course content

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Encouraging FUN and CREATIVITY can turn classroom learning into an ALL-IN learning opportunity.

$$= \omega I \eta$$