Creating the Ultimate Flipped Classroom

Leadership program for the Brazil STHEM Consortium
Harvard University
Cambridge, 22 April 2016

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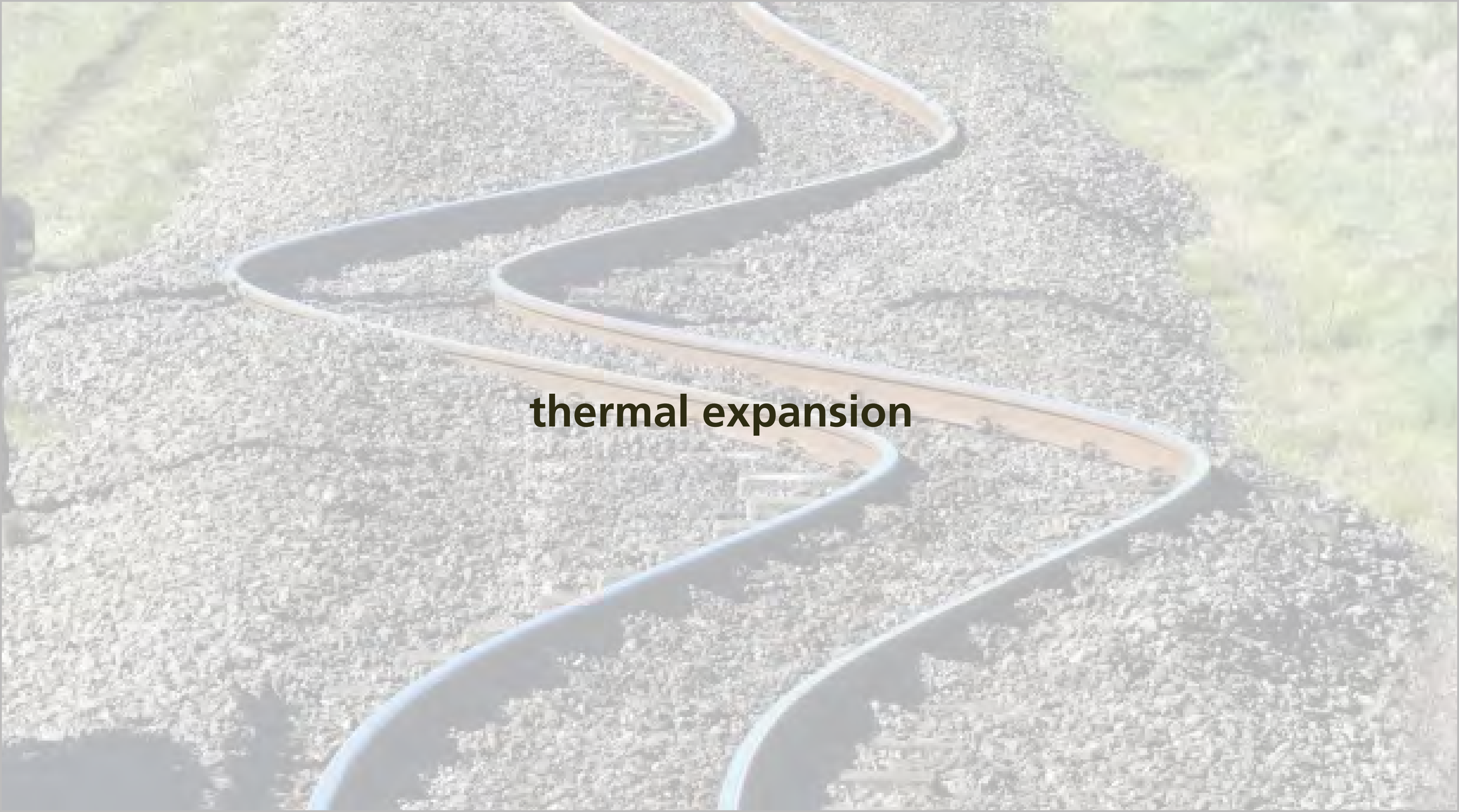
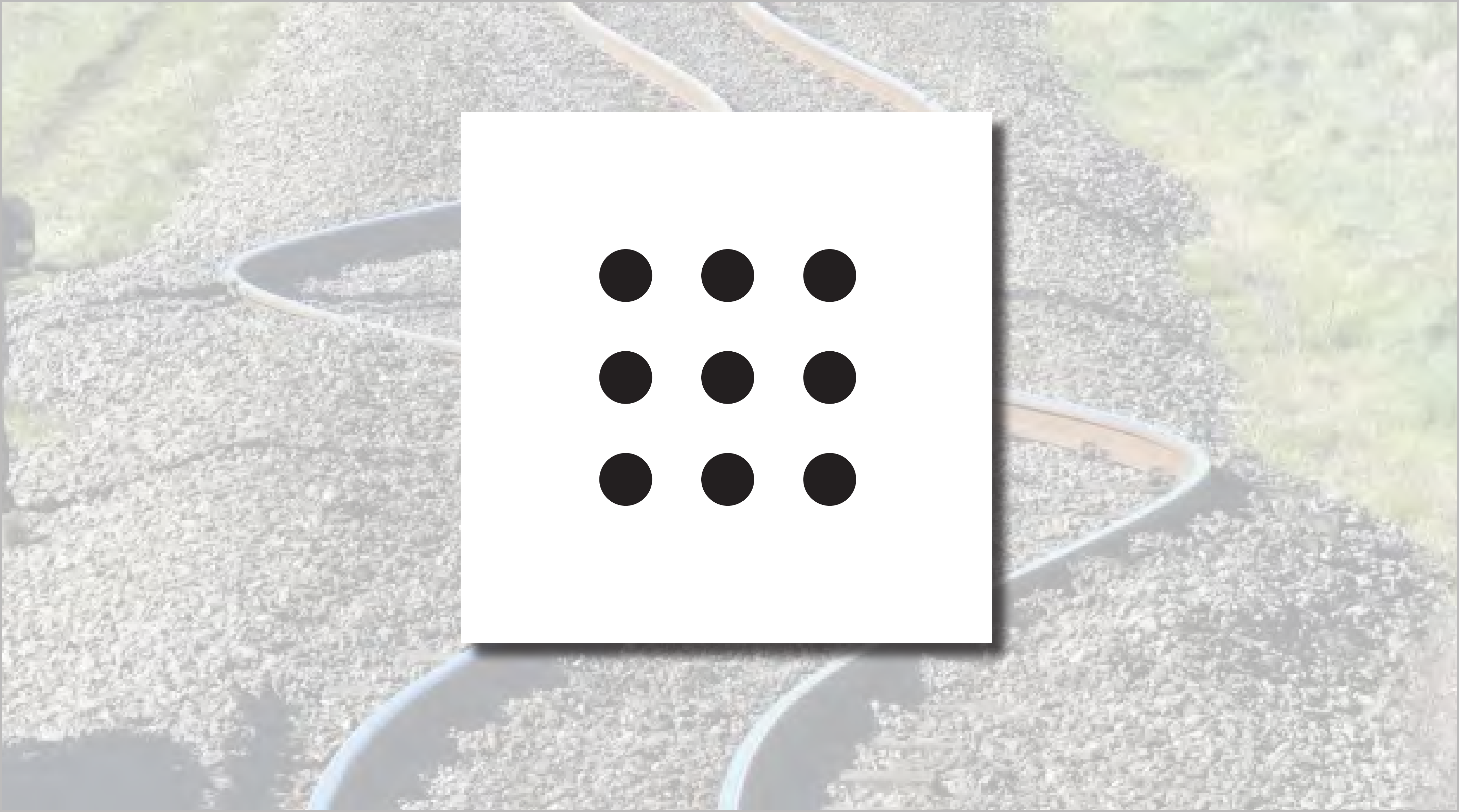
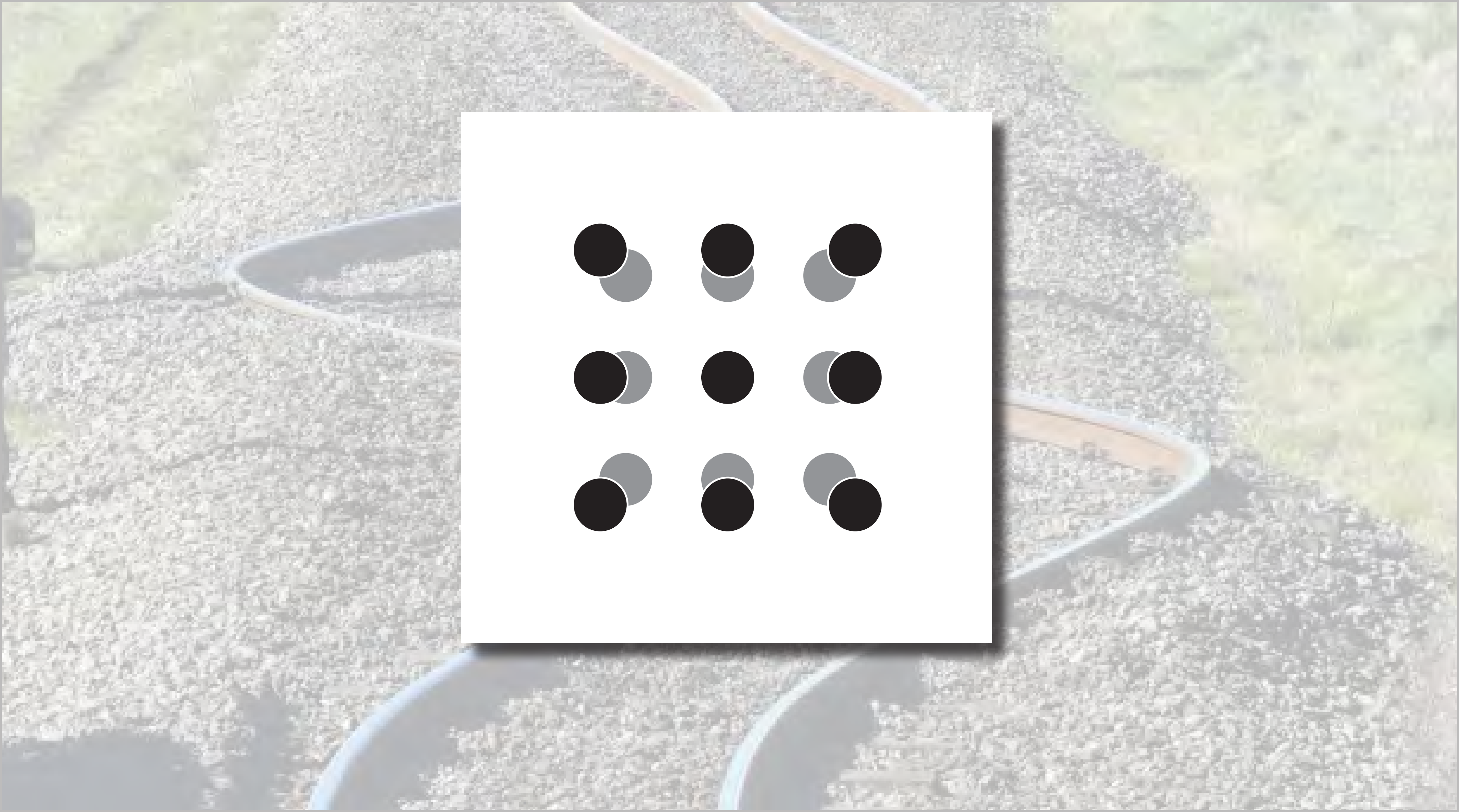
thermal expansion

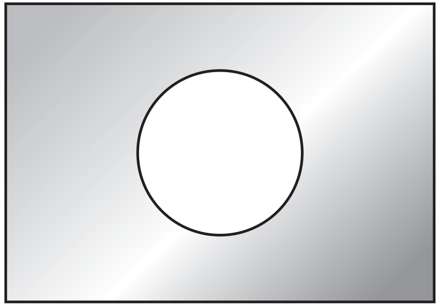







all of them

Consider a rectangular metal plate with a circular hole in it.



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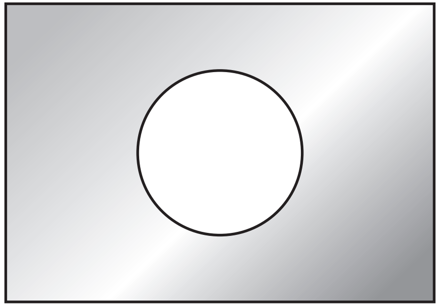

When the plate is uniformly heated, the diameter of the hole

1. increases.
2. stays the same.
3. decreases.

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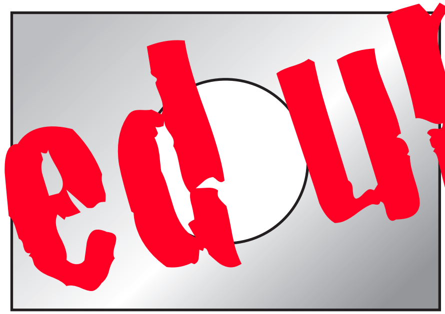

When the plate is uniformly heat-ed, the diameter of the hole

1. increases.
2. stays the same.
3. decreases.

you got all fired up!

Before I tell you the answer, let's analyze what happened.

Before I tell you the answer, let's analyze what happened.

You…

Before I tell you the answer, let's analyze what happened.

You…

1. made a commitment

Before I tell you the answer, let's analyze what happened.

You…

1. made a commitment
2. externalized your answer

Before I tell you the answer, let’s analyze what happened.

You…

1. made a commitment
2. externalized your answer
3. moved from the answer/fact to reasoning

Before I tell you the answer, let's analyze what happened.

You…

1. made a commitment
2. externalized your answer
3. moved from the answer/fact to reasoning
4. became emotionally invested in the learning process

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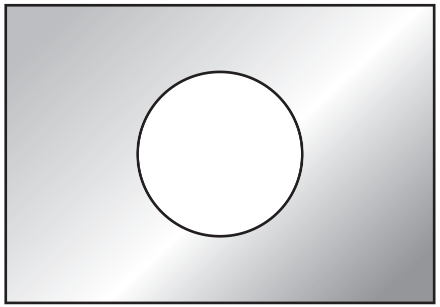

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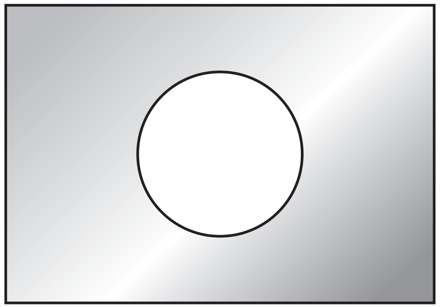

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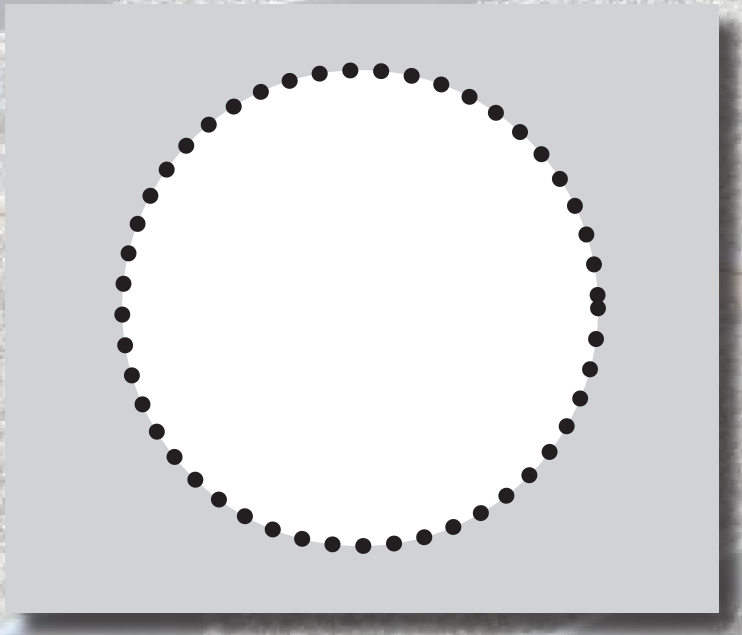
1. increases. ✔
2. stays the same.
3. decreases.

consider atoms at rim of hole



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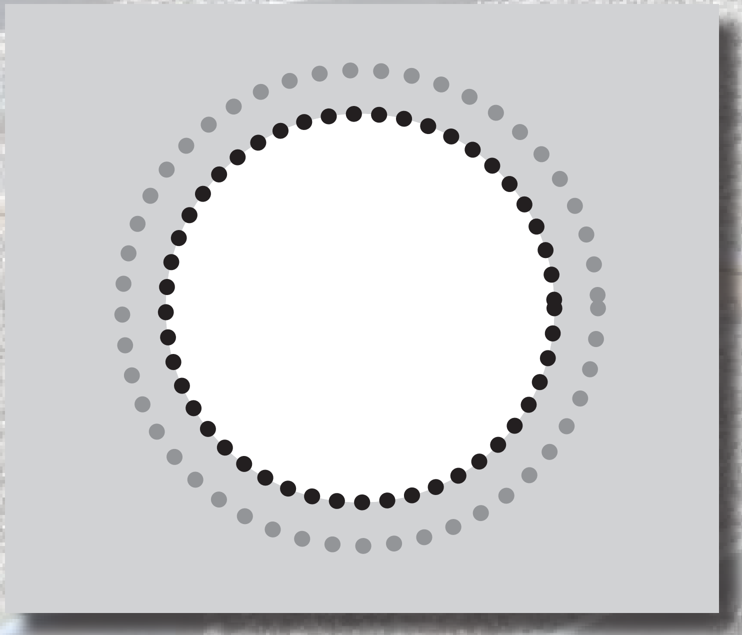

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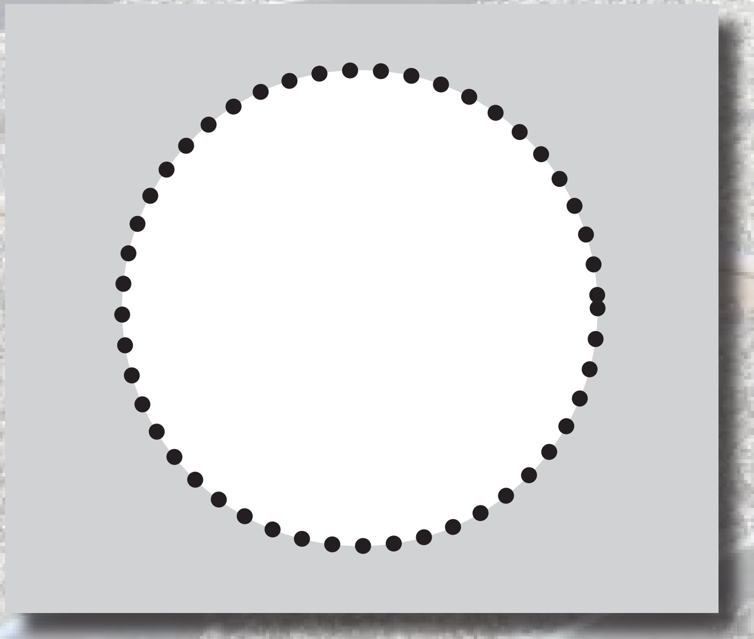

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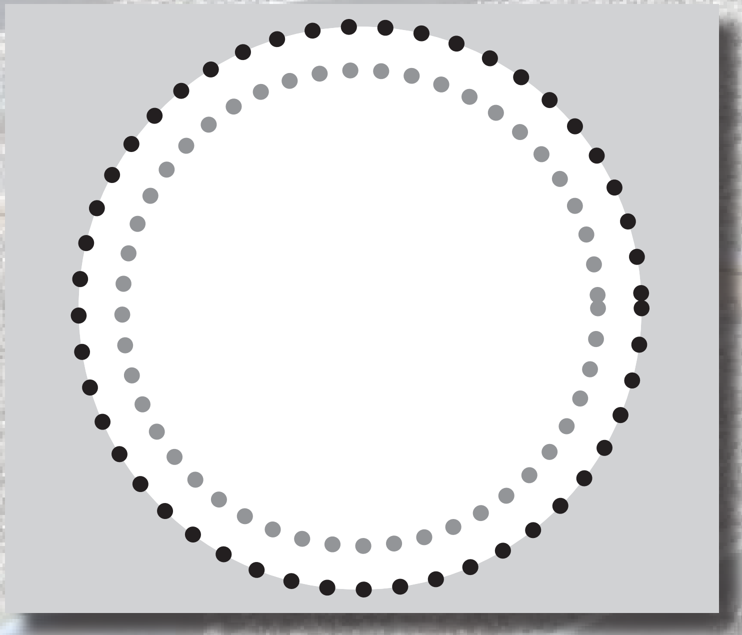


consider atoms at rim of hole

you won't forget this

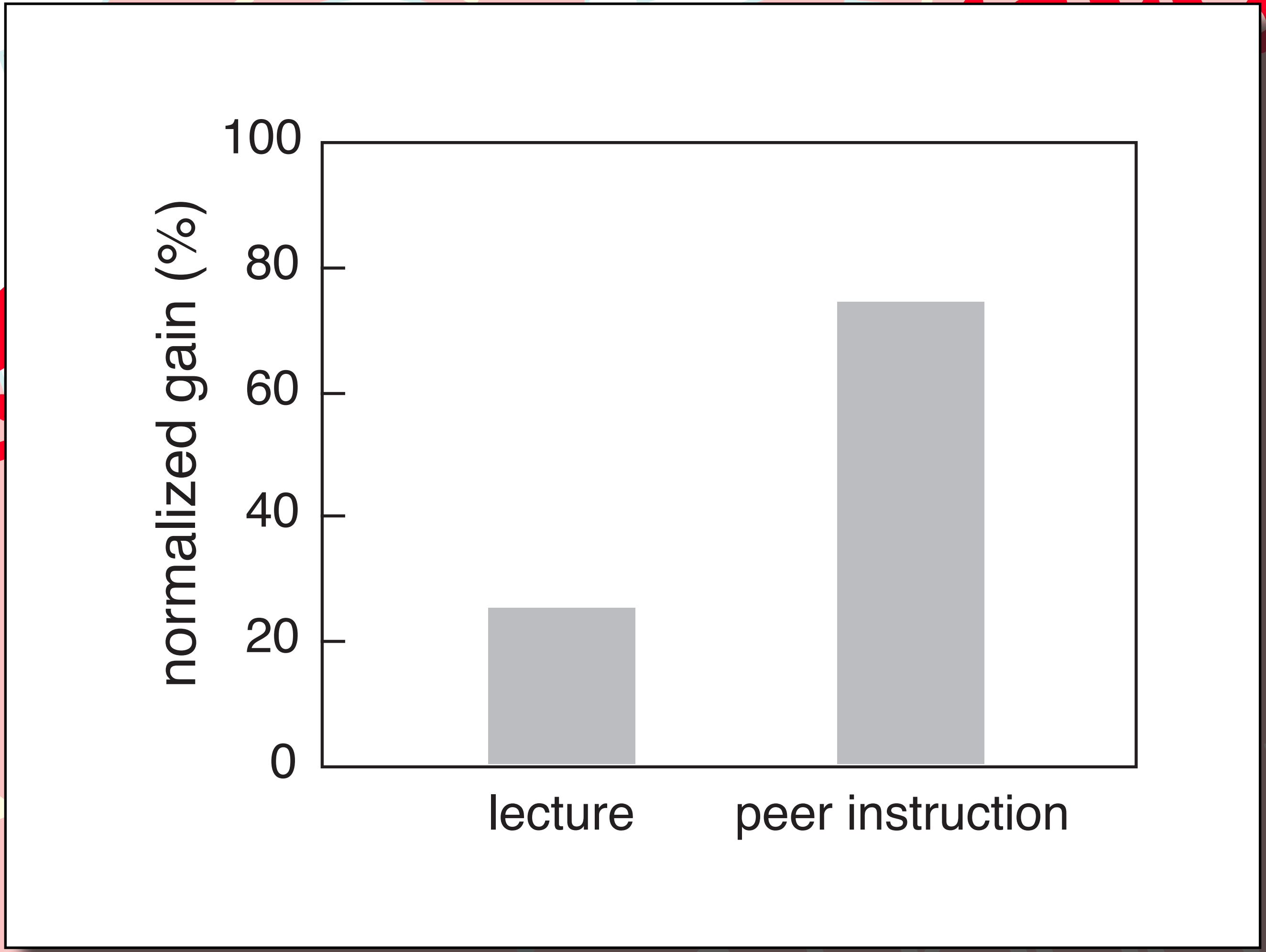
Pee

back to Pl

INSTRUCTION

Higher learning gains

INSTRUCTION

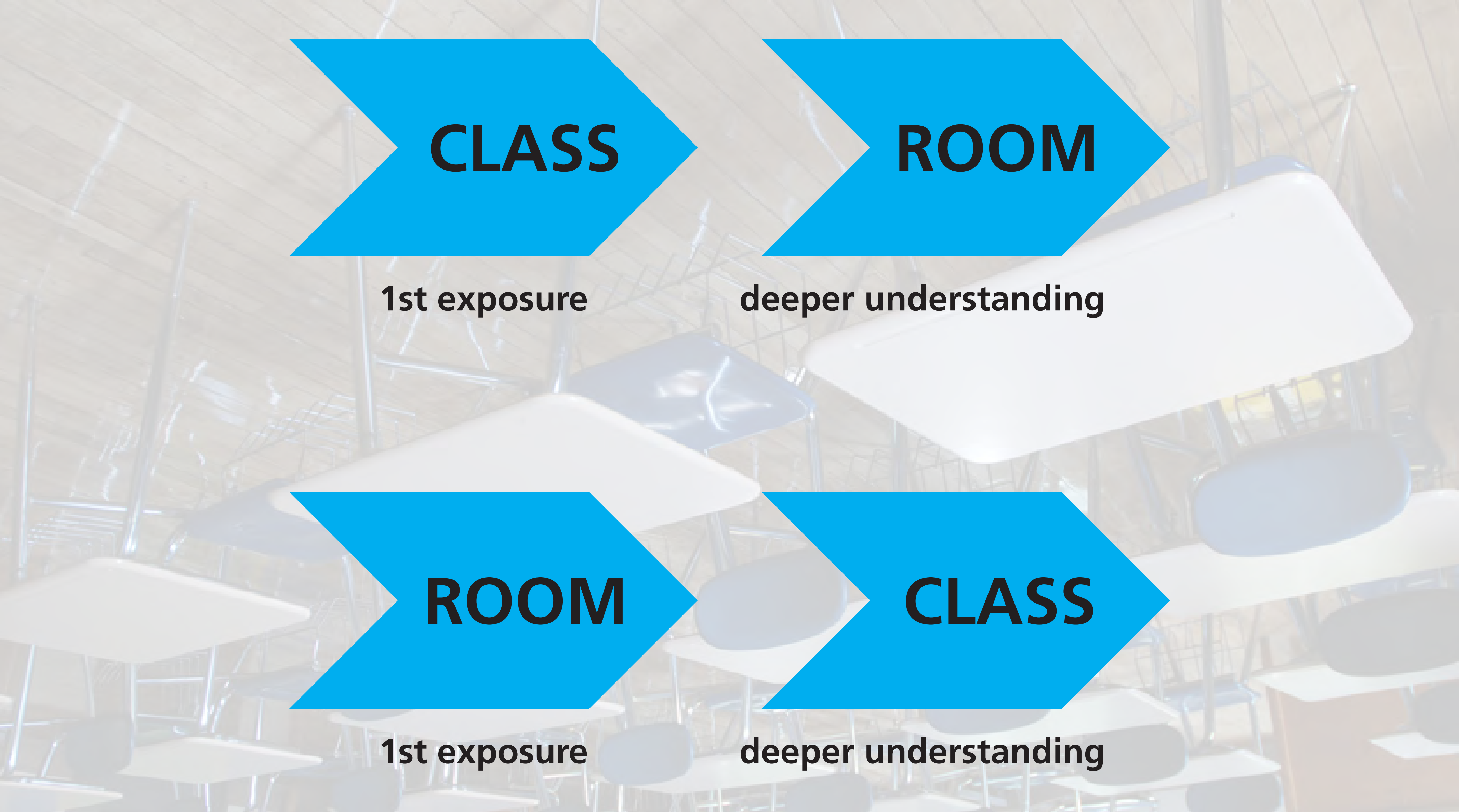

normalized gain (%)
0
20
40
60
80
100
lecture
peer instruction

Higher learning gains

Better retention

INSTRUCTION


CLASS
ROOM
1st exposure
deeper understanding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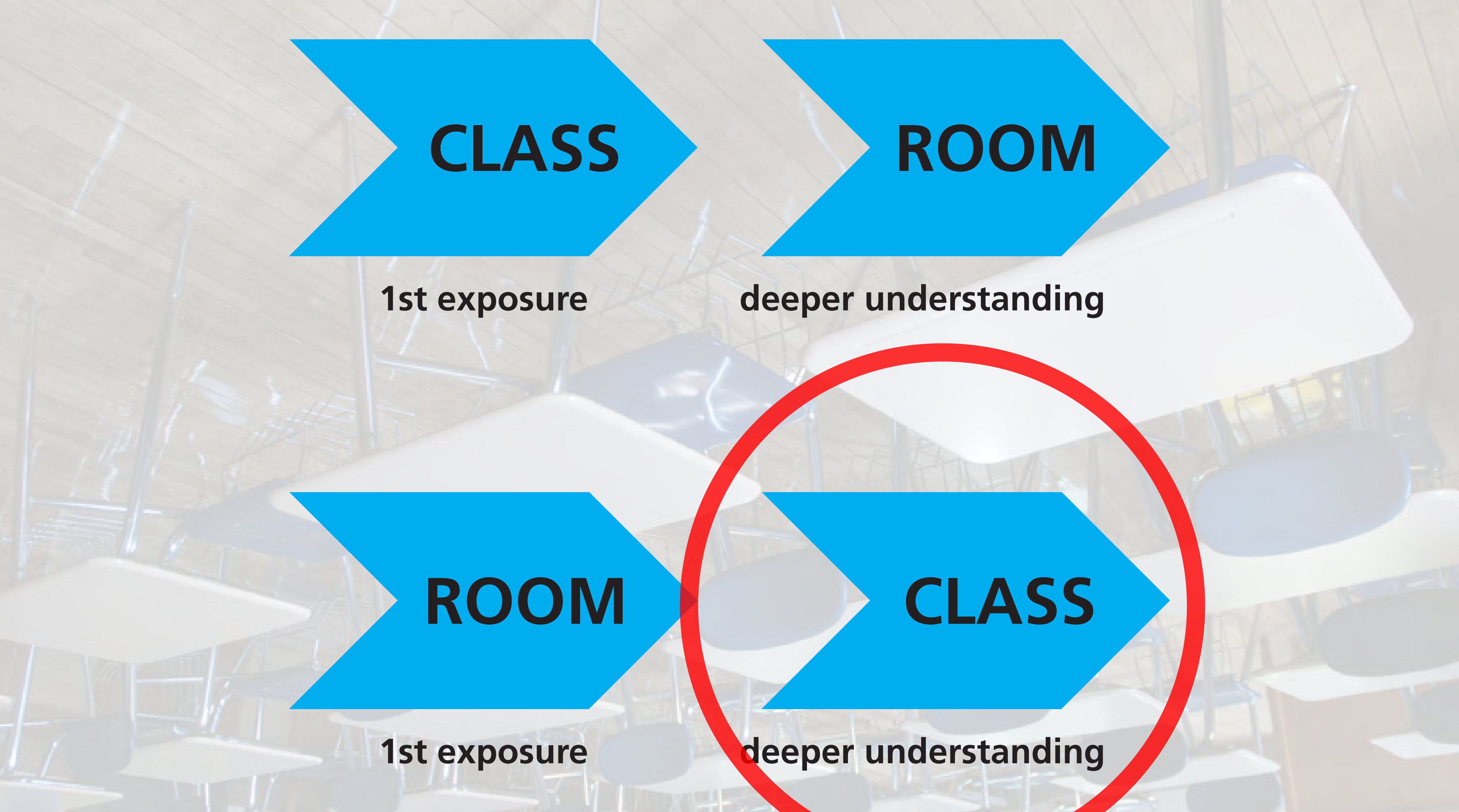
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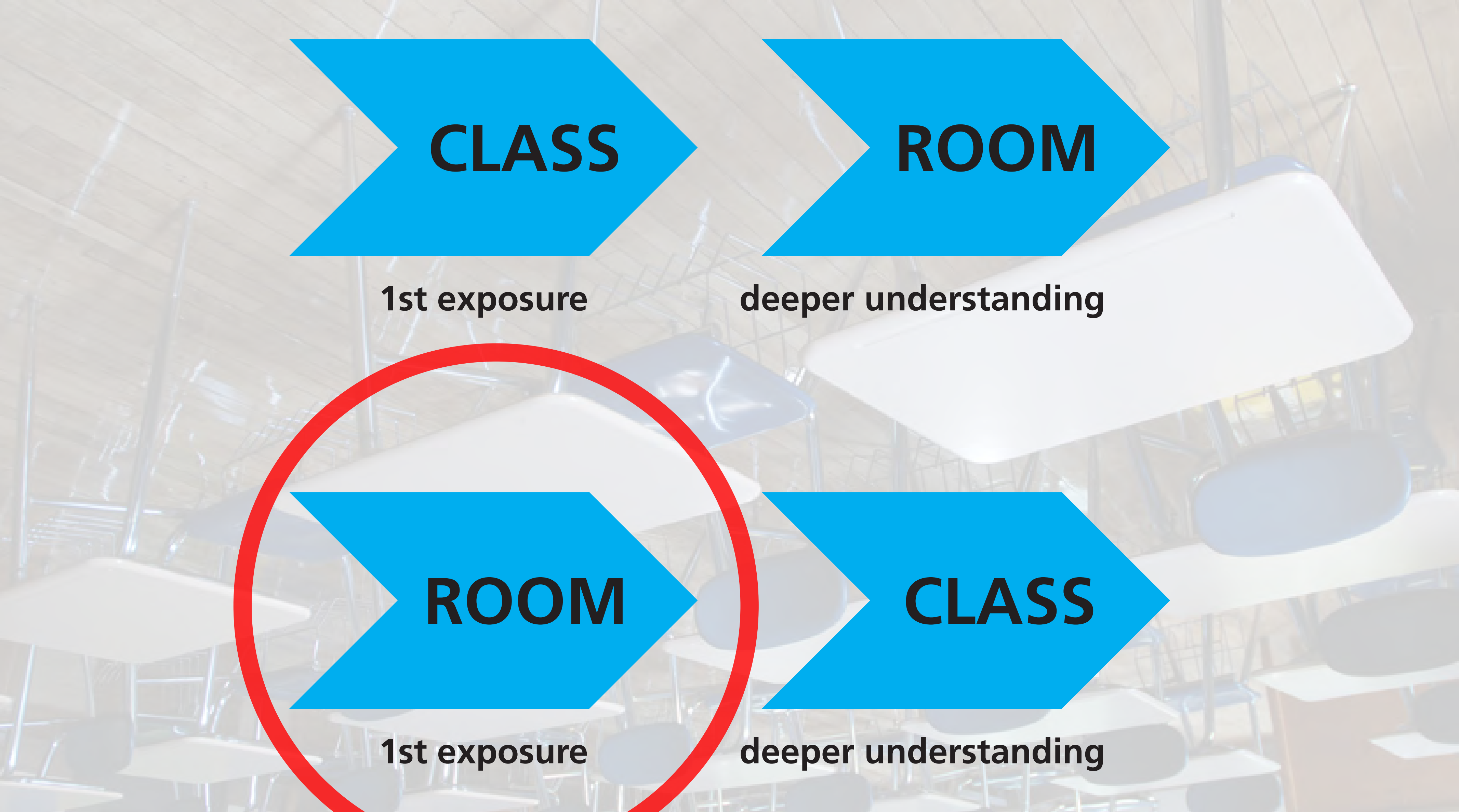
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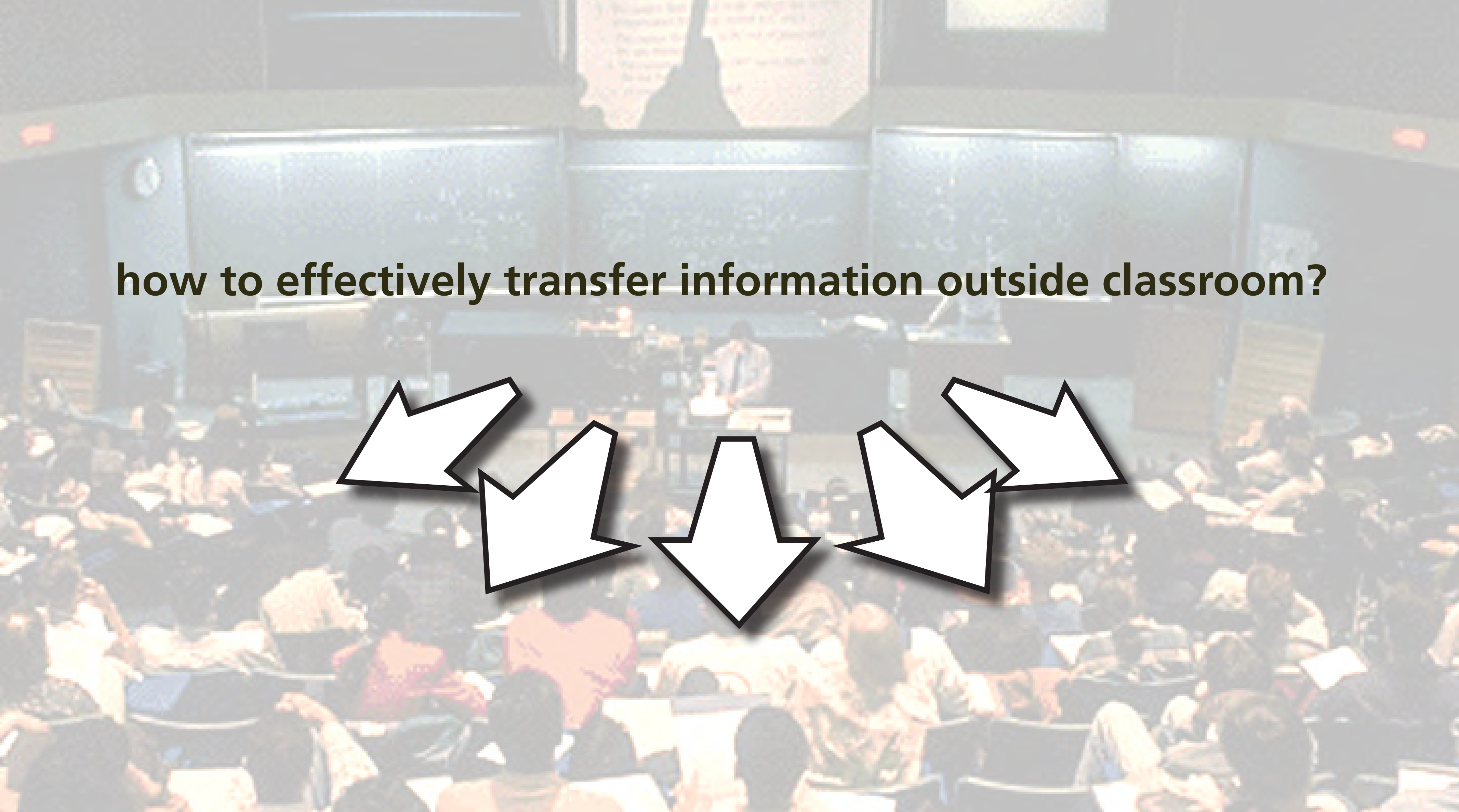
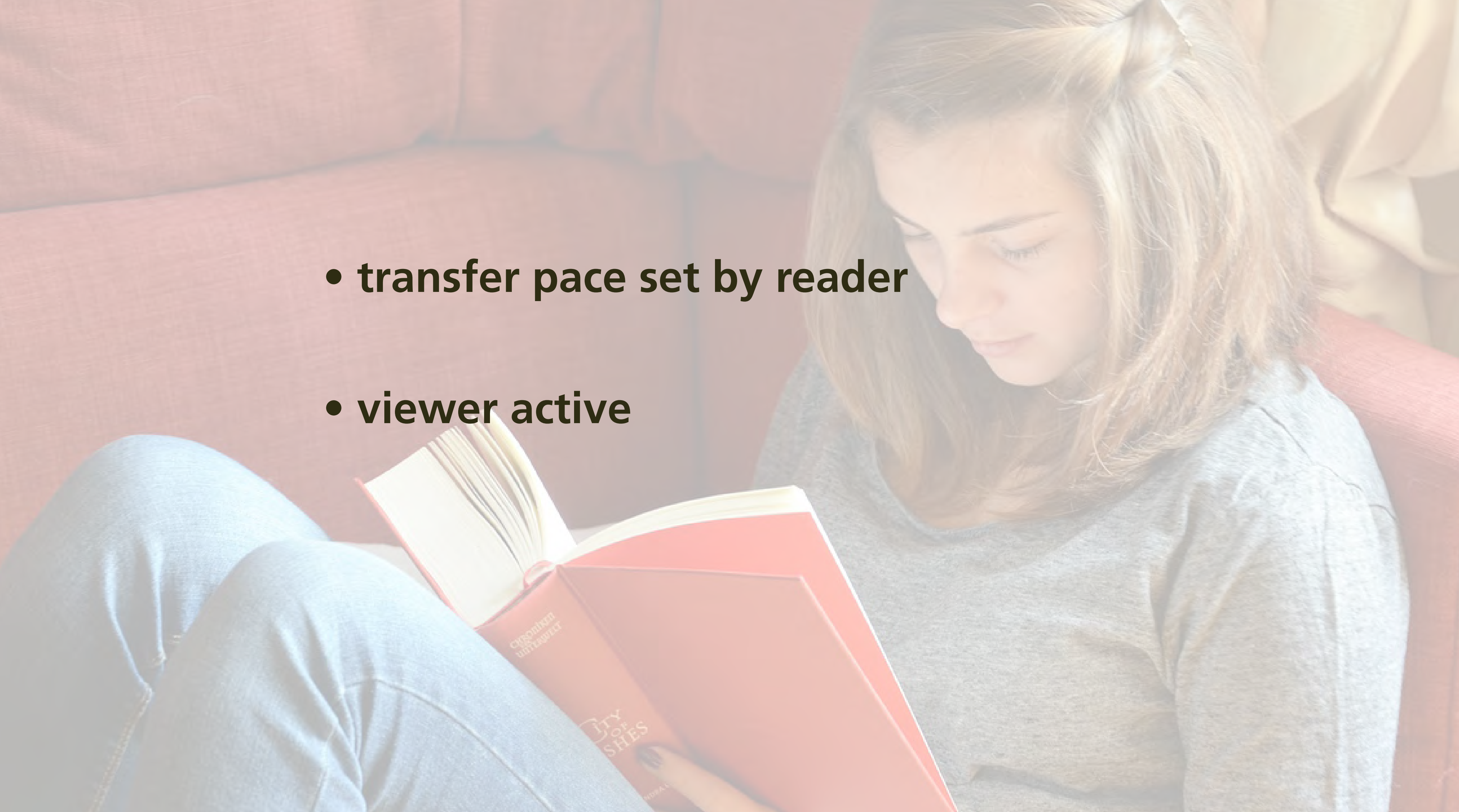

how to effectively transfer information outside classroom?


P=4a
a
d

but…

- transfer pace set by video
- viewer passive
- viewing/attention tanks as time passes
- isolated/individual experience


we’re simply moving this outside classroom!



- **transfer pace set by reader**
- **viewer active**

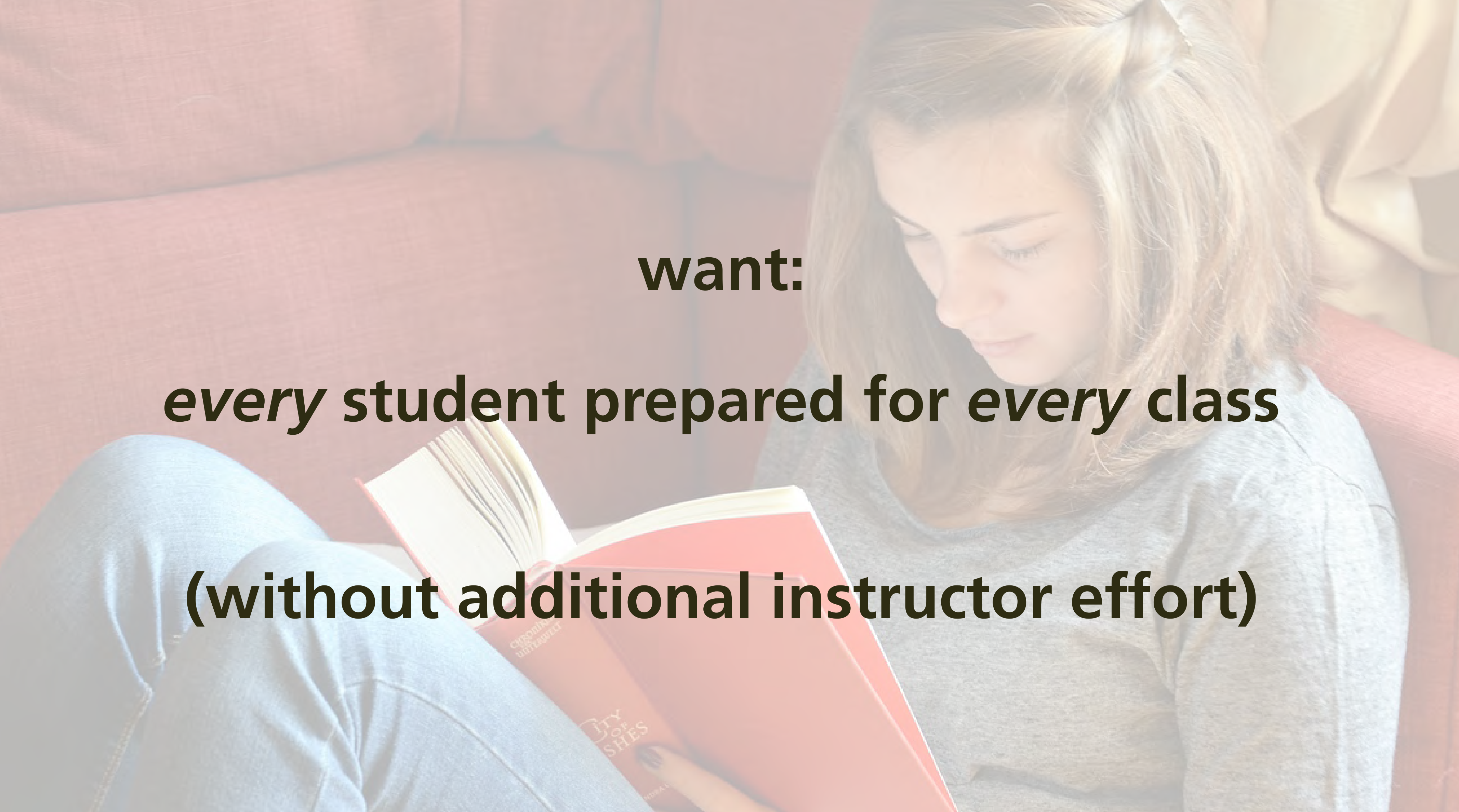
but…

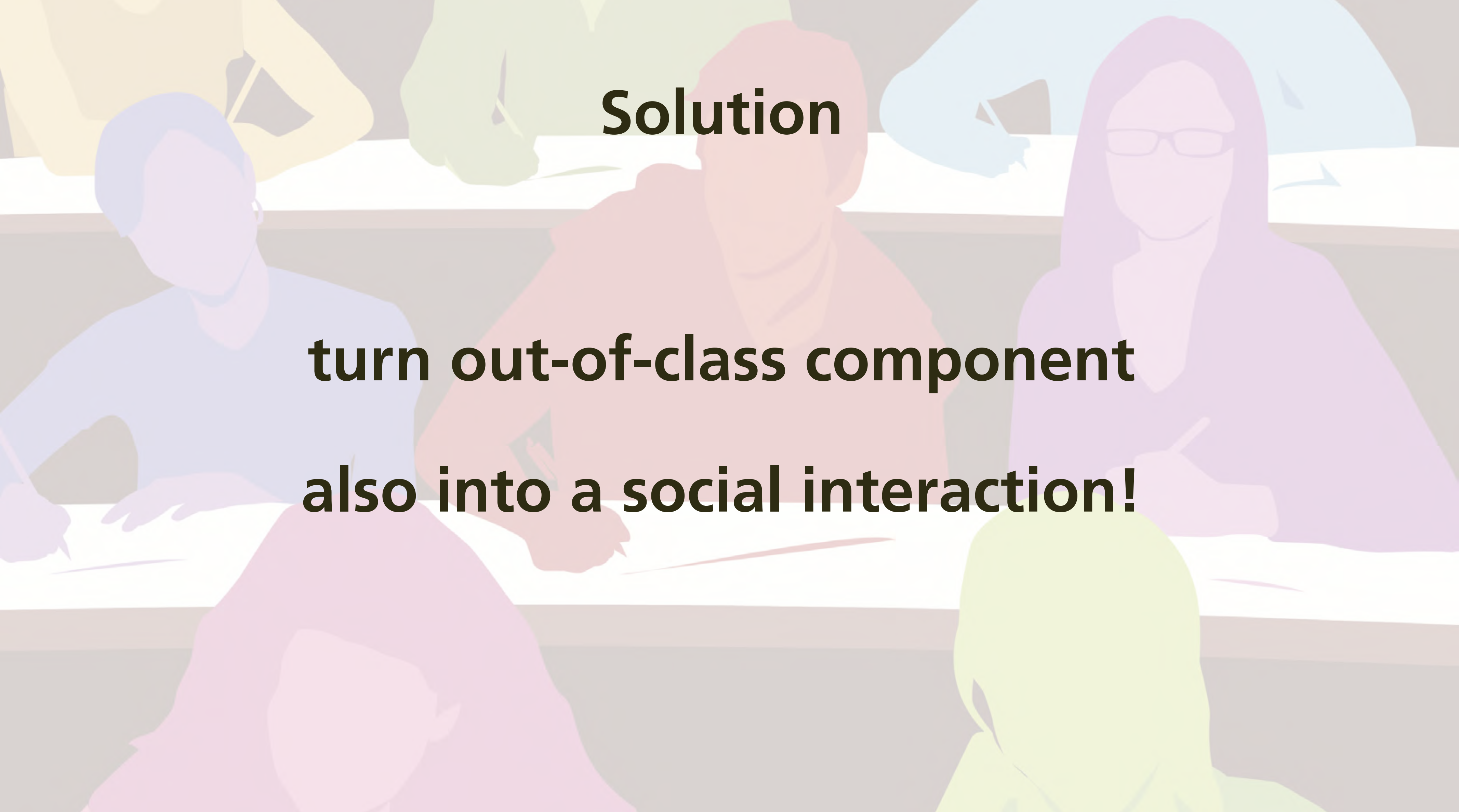
isolated/individual experience &

no real accountability

want:

every student prepared for *every* class

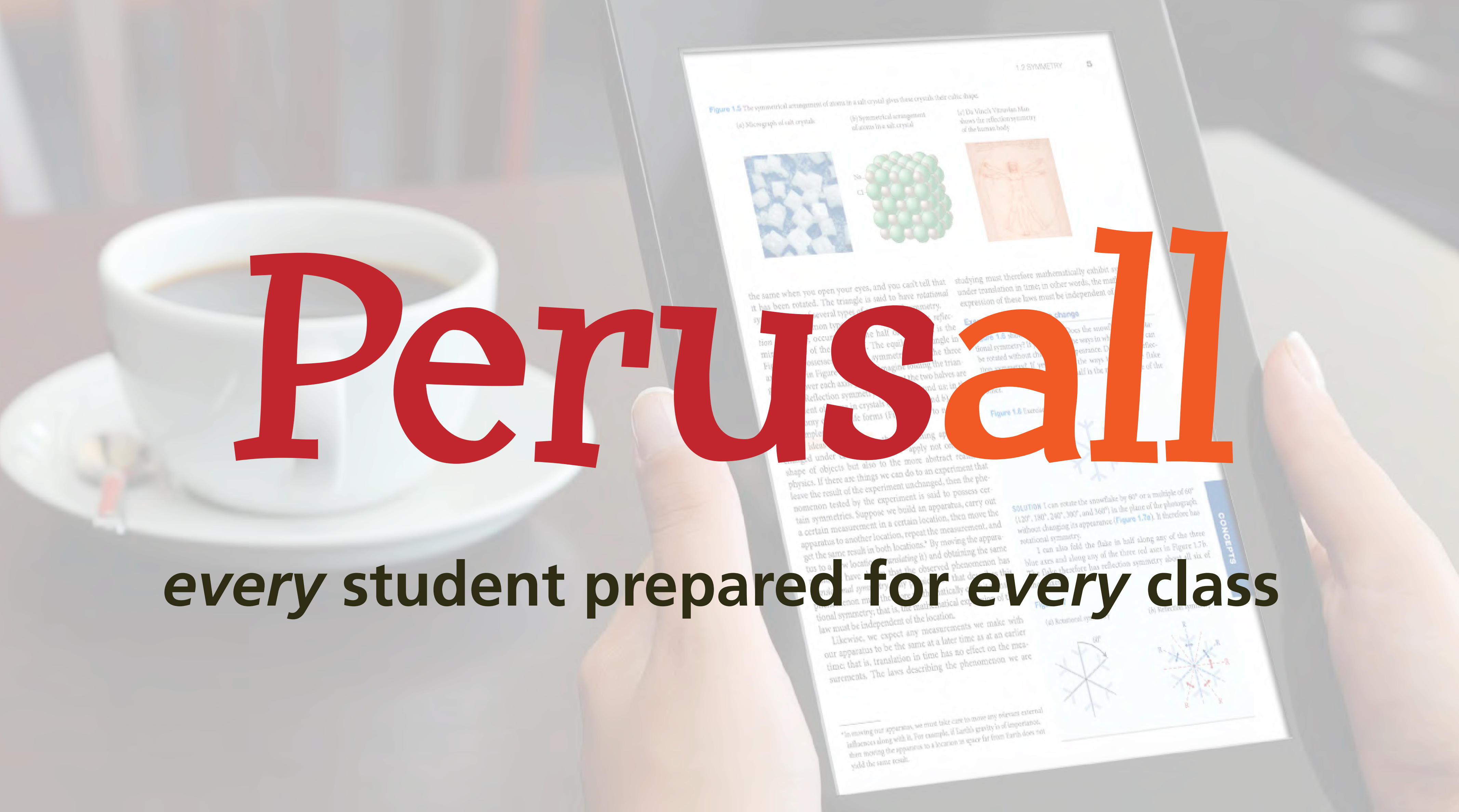

want:
every student prepared for *every* class
(without additional instructor effort)

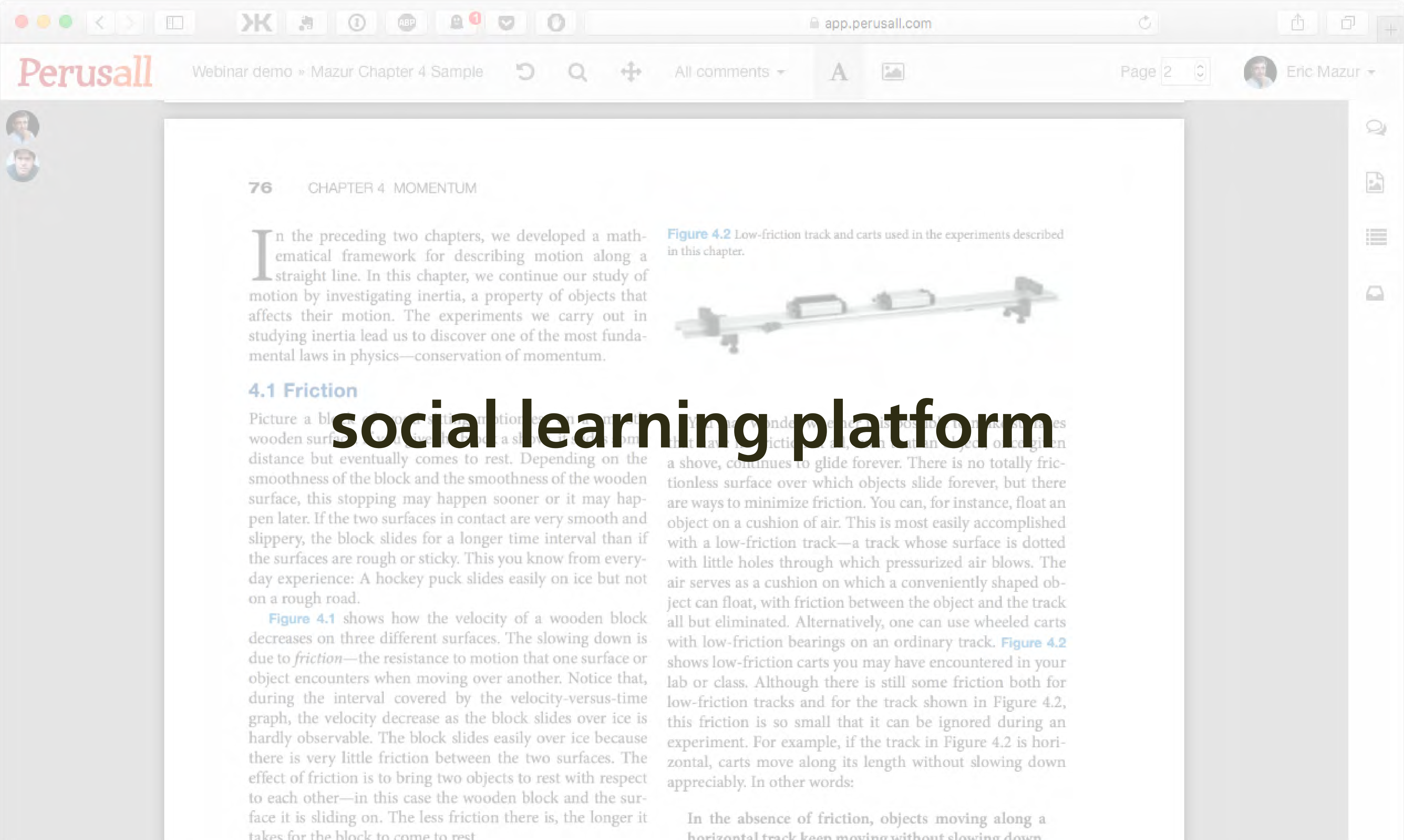


Solution

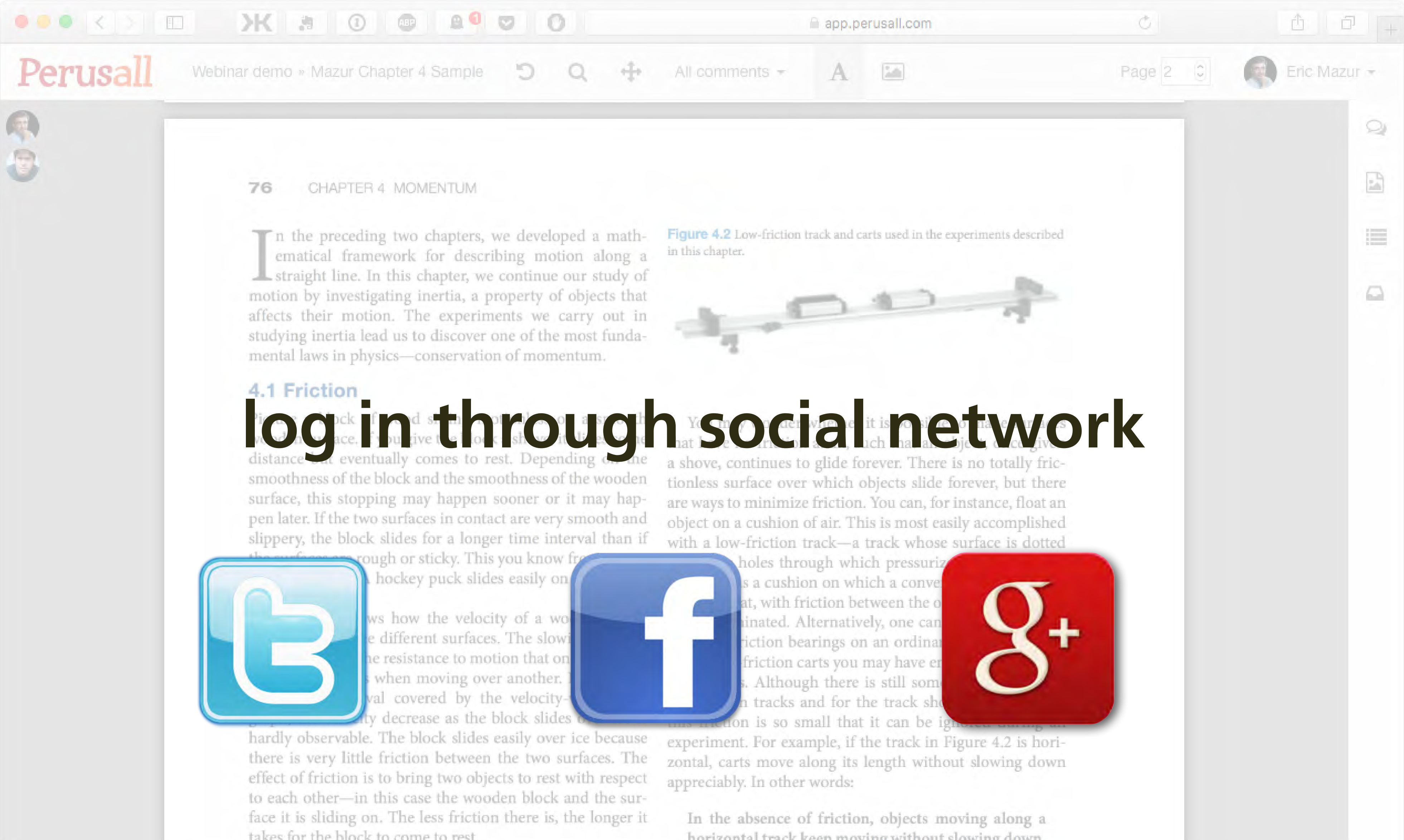
turn out-of-class component

also into a social interaction!


Perusall
every student prepared for *every* class



social learning platform



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Webinar demo » Mazur Chapter 4 Sample
All comments
Page 2
Eric Mazur
76 CHAPTER 4 MOMENTUM
In the preceding two chapters, we developed a mathematical framework for describing motion along a straight line. In this chapter, we continue our study of motion by investigating inertia, a property of objects that affects their motion. The experiments we carry out in studying inertia lead us to discover one of the most fundamental laws in physics—conservation of momentum.
Figure 4.2 Low-friction track and carts used in the experiments described in this chapter.
4.1 Friction
log in through social network

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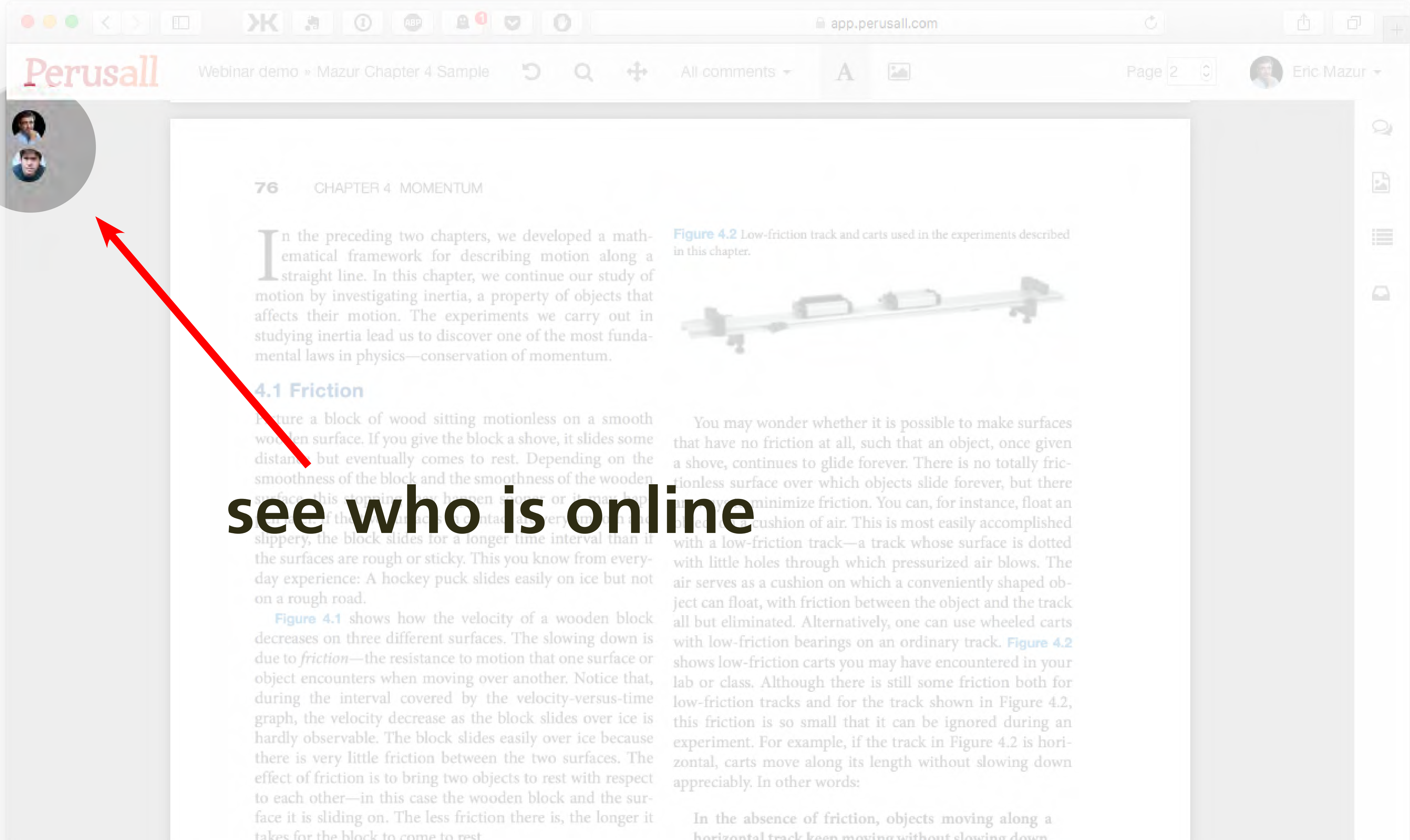
In the absence of friction, objects moving along a horizontal track keep moving without slowing down.



see who is online

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Another advantage of using such carts is that the track constrains the motion to being along a straight line. We can then use a high-speed camera to record the cart's position at various instants, and from that information determine its speed and acceleration.

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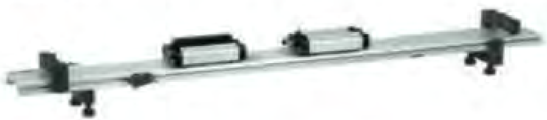

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...opens chat window

Enter your comment or question and press Enter

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No friction at all seems impossible. Isn't there always some friction in any real case.

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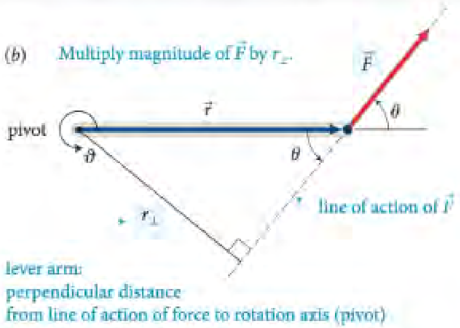
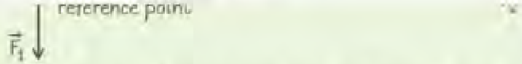


action of the force and the axis of rotation. So, the torque caused by a force exerted on an object is the product of the magnitude of the force and its lever arm distance. It can be written equivalently as $rF_\perp$ and as $r_\perp F$.

Like other rotational quantities, torque carries a sign that depends on the choice of direction for increasing ϑ. In Figure 12.4, for example, the torque caused by $\vec{F}_1$ about the pivot tends to rotate the rod in the direction of increasing ϑ and so is positive; the torque caused by $\vec{F}_2$ is negative. The sum of the two torques about the pivot is then $r_1F_1 + (-r_2F_2)$. As we've seen, the two torques are equal in magnitude when the rod is balanced, and so the sum of the torques is zero. When the sum of the torques is not zero, the rod's rotational acceleration is nonzero, and so its rotational velocity and angular momentum change.

In the situations depicted in Figures 12.4 and 12.5 we used the pivot to calculate the lever arm distances. This is a natural choice because that is the point about which the object under consideration is free to rotate. However, torques also play a role for stationary objects that are suspended or supported at several different points and that are not free



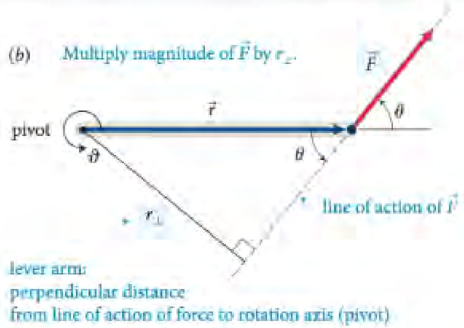
The lever arm distances must now be determined relative to the left end of the rod. The lever arm distance of force $\vec{F}_1$ to this point is zero, and so the torque caused by that force about the left end of the rod is zero. If I choose counterclockwise as the positive direction of rotation, $\vec{F}_2$ causes a negative torque about the left end of the rod; the force $\vec{F}^c_{pr}$ exerted by the pivot causes a positive torque about the left end of the rod. The lever arm distance of $\vec{F}_2$ about the left end of the rod is $r_1 + r_2$; that of $\vec{F}^c_{pr}$ is r_1. Because the rod is at rest, the magnitude of the force exerted by the pivot is equal to the sum of the forces $\vec{F}_1$ and $\vec{F}_2$. Taking into account the signs of the torques, we find that the sum of the torques about the left end of the rod is $r_1(F_1 + F_2) - (r_1 + r_2)F_2 = r_1F_1 - r_2F_2$. This is the same result we obtained for the torques about the pivot, and so the sum of the torques about the left end is zero. ✔

Exercise 12.1 shows that the sum of the torques about the left end of the rod is zero, just like the sum of the torques about the pivot. You can repeat the calculation for the torques about the right end of the rod or any other point, and each time you will find that the sum of the torques is zero. The reason is that the rod is not rotating about any point, and so the sum of the torques must be zero about any point. In general we can say:

For a stationary object, the sum of the torques is zero.

For a stationary object we can choose any reference point we like to calculate torques. It pays to choose a reference point that simplifies the calculation. As you have seen, we do not need to consider any force that is exerted at the reference point. So, by putting the reference point at the point of application of a force, we can eliminate that force from the calculation.

12.2 In the situation depicted in Figure 12.3a, you must



action of the force and the axis of rotation. So, the torque caused by a force exerted on an object is the product of the magnitude of the force and its lever arm distance. It can be

I don't understand how this combination of factors tells you anything about direction? Aren't magnitude and lever arm distance both scalar quantities? It seems like we would need to know some sort of direction to calculate torque. Oct 20 12:09 am

I think you may be able to think about the direction separately. So, after multiplying this magnitude and distance, you can attach a sign to the torque based on the defined parameters of the system. In the following paragraph, they start to explain how to choose this direction. Oct 20 12:38 am

This is a great question. To further elaborate on this, we can think of this in terms of the Torque equation. The equation for torque is τ = r X F, with r being the level arm distance and F being force. We know that force is a vector vector from previous Oct 22 8:48 pm

reference point

$\vec{F}_1$

The lever arm distances must now be determined relative to the left end of the rod. The lever arm distance of force $\vec{F}_1$ to this point is zero, and so the torque caused by that force about the left end of the rod is zero. If I choose counterclockwise as the positive direction of rotation, $\vec{F}_2$ causes a negative torque about the left end of the rod; the force $\vec{F}^c_{pr}$ exerted by the pivot causes a positive torque about the left end of the rod. The lever arm distance of $\vec{F}_2$ about the left end of the rod is $r_1 + r_2$; that of $\vec{F}^c_{pr}$ is r_1. Because the rod is at rest, the magnitude of the force exerted by the pivot is equal to the sum of the forces $\vec{F}_1$ and $\vec{F}_2$. Taking into account the signs of the torques, we find that the sum of the torques about the left end of the rod is $r_1(F_1 + F_2) - (r_1 + r_2)F_2 = r_1F_1 - r_2F_2$. This is the same result we obtained for the torques about the pivot, and so the sum of the torques about the left end is zero. ✔

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12.2 In the situation depicted in Figure 12.2a, you must

Perusall

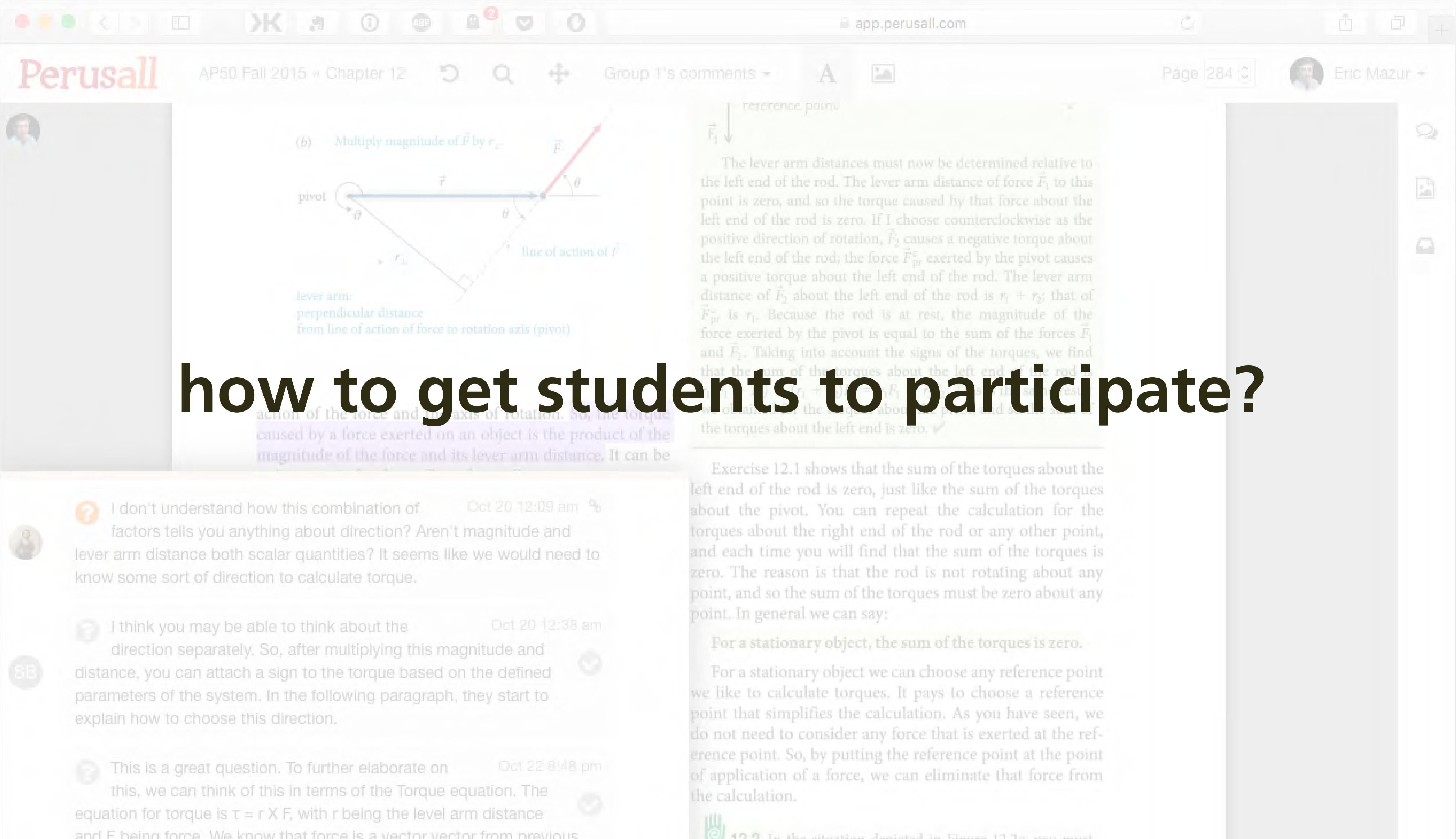
Eric Mazur

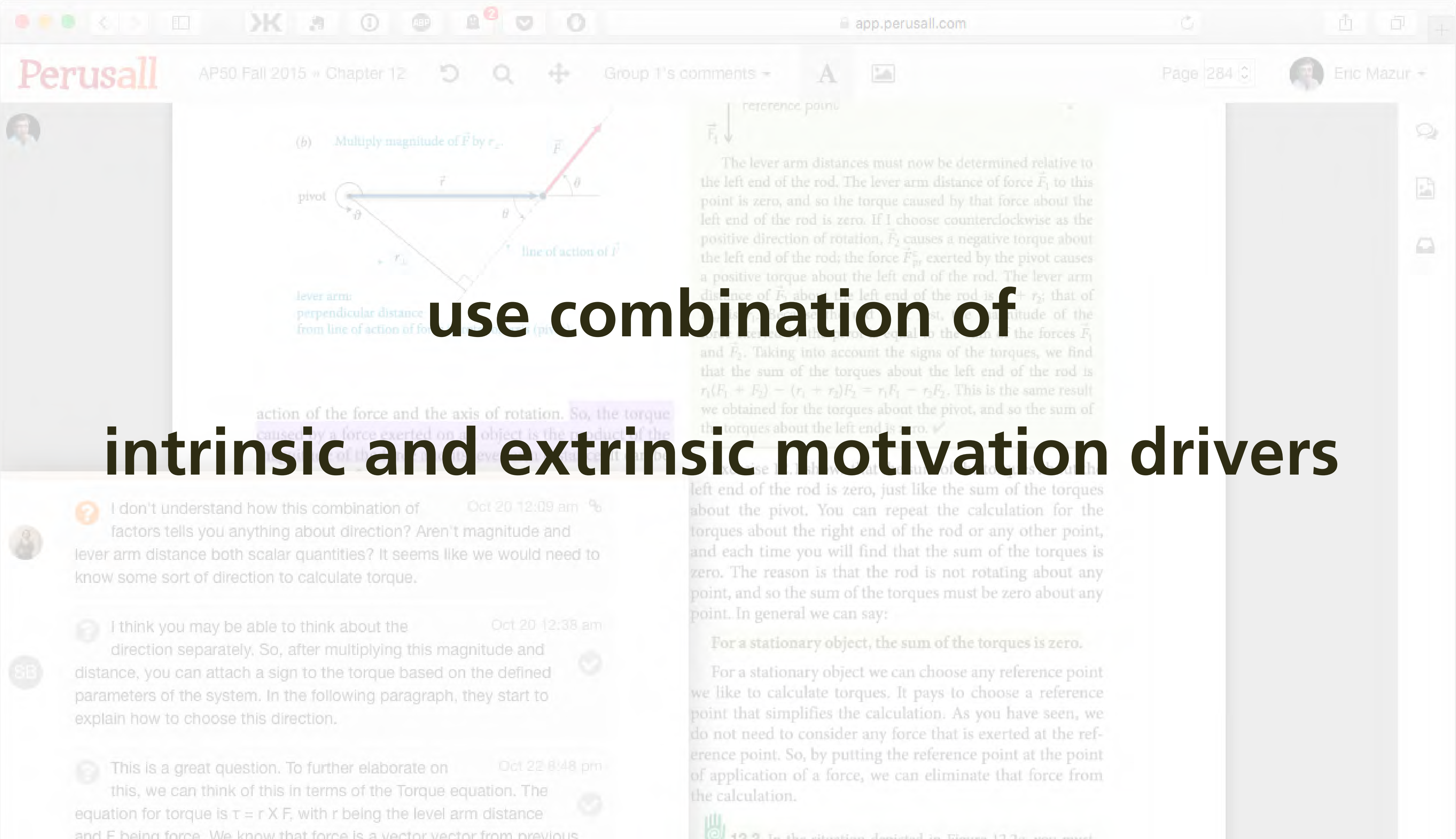
I don't understand how this combination of factors tells you anything about direction? Aren't magnitude and lever arm distance both scalar quantities? It seems like we would need to know some sort of direction to calculate torque. Oct 20 12:09 am

I think you may be able to think about the direction separately. So, after multiplying this magnitude and distance, you can attach a sign to the torque based on the defined parameters of the system. In the following paragraph, they start to explain how to choose this direction. Oct 20 12:38 am

This is a great question. To further elaborate on this, we can think of this in terms of the Torque equation. The equation for torque is $\tau = r \times F$, with r being the level arm distance and F being force. We know that force is a vector vector from previous chapters, and in regards to "r" it can also be thought of as the radial vector. What this means is that this distance from the pivot points from the axis of rotation to the point where the force acts. In as previously mentioned, there is a general convention (the right-hand rule) that is used to determine the direction which happens to be perpendicular to both the radius from the axis and to the force. Oct 22 8:48 pm

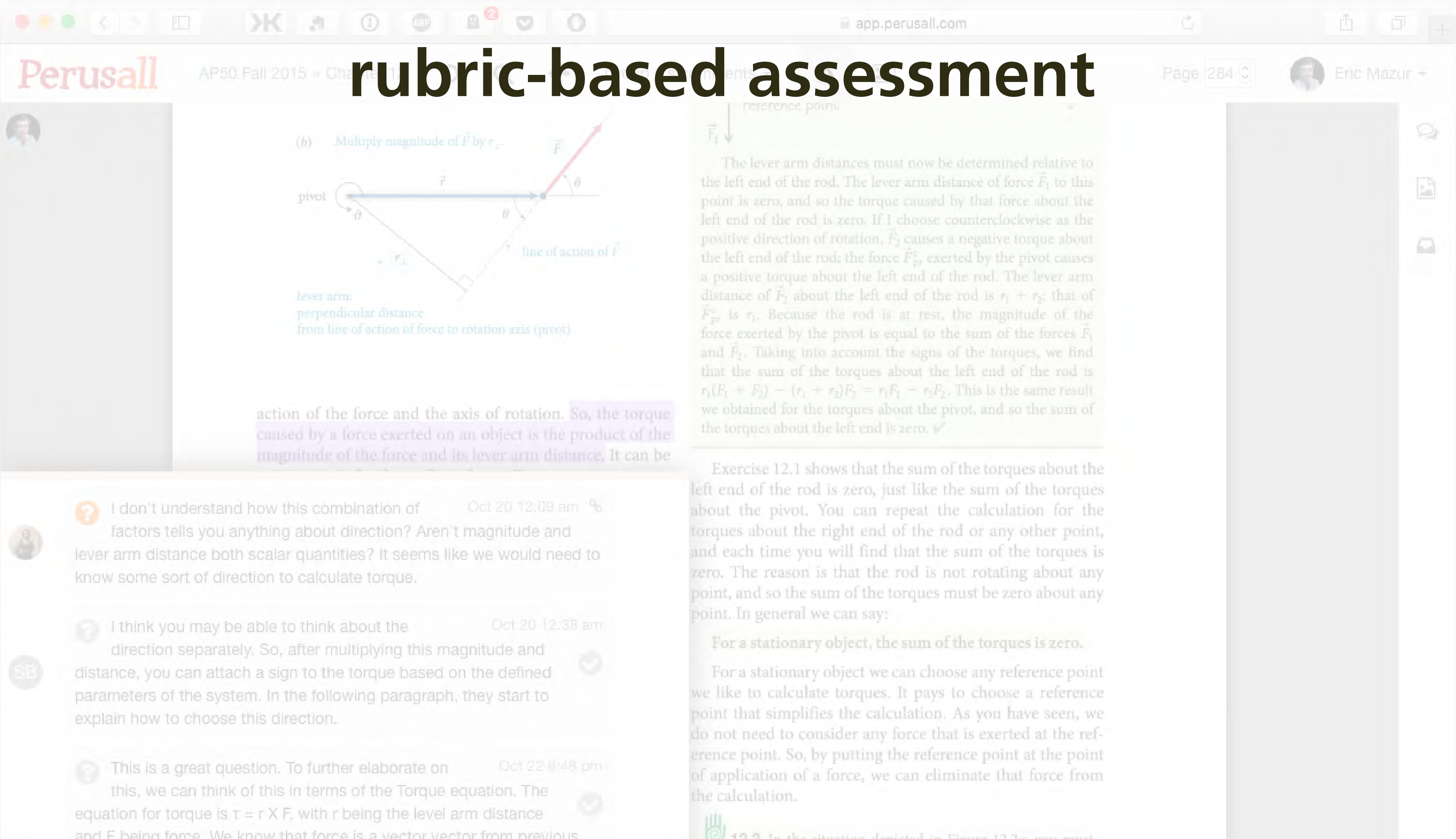
how to get students to participate?





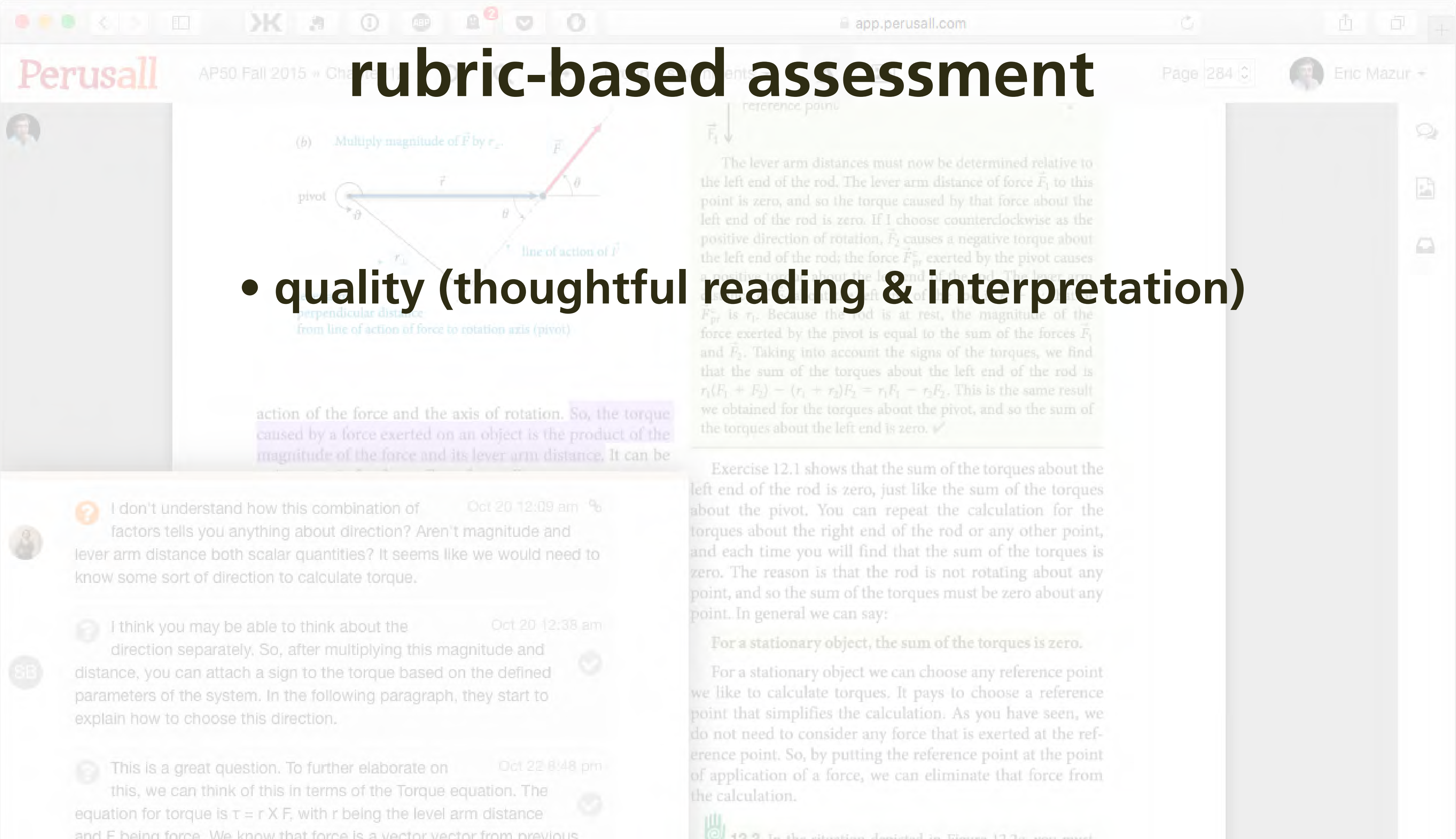
use combination of intrinsic and extrinsic motivation drivers

rubric-based assessment



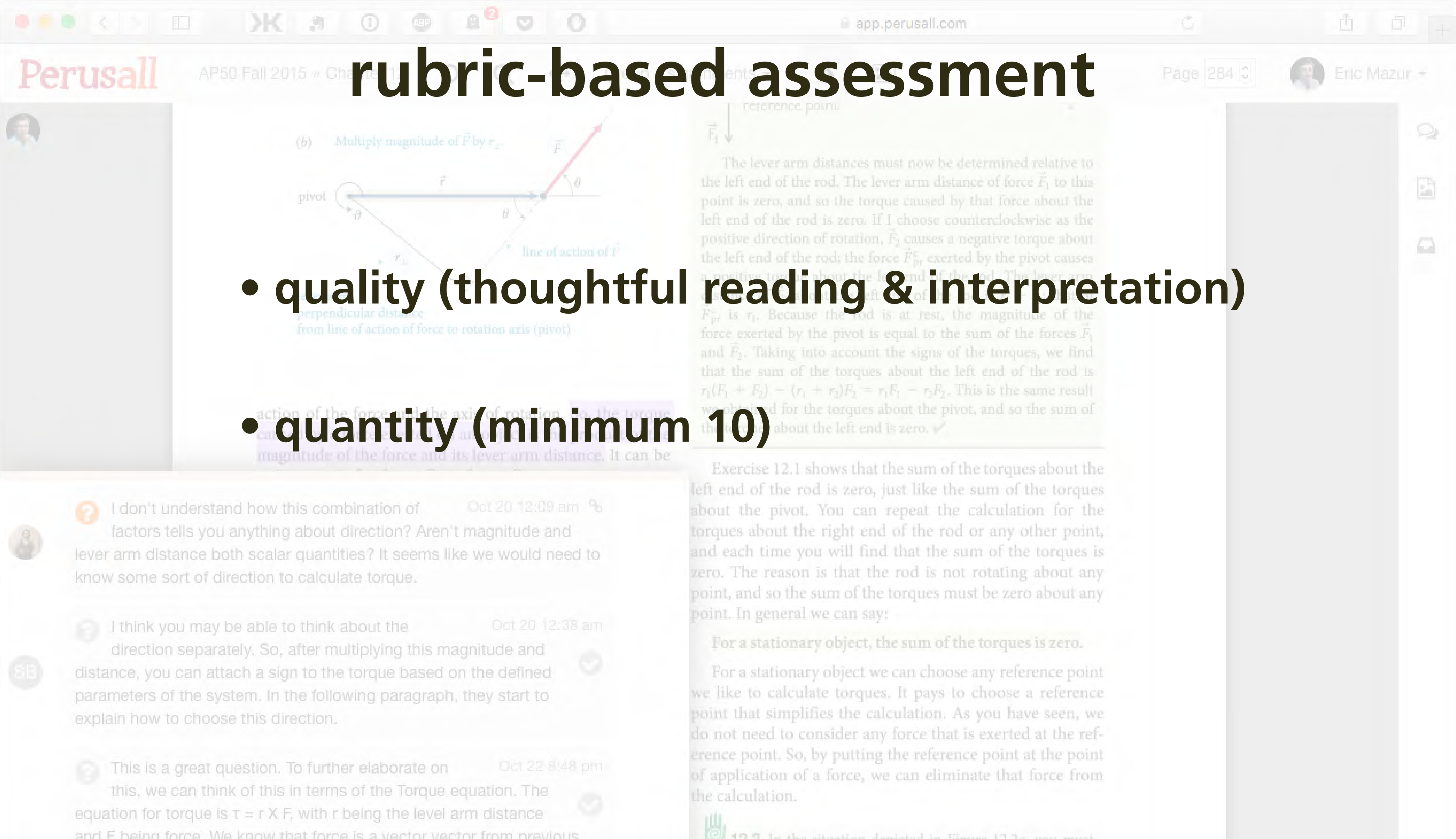
rubric-based assessment

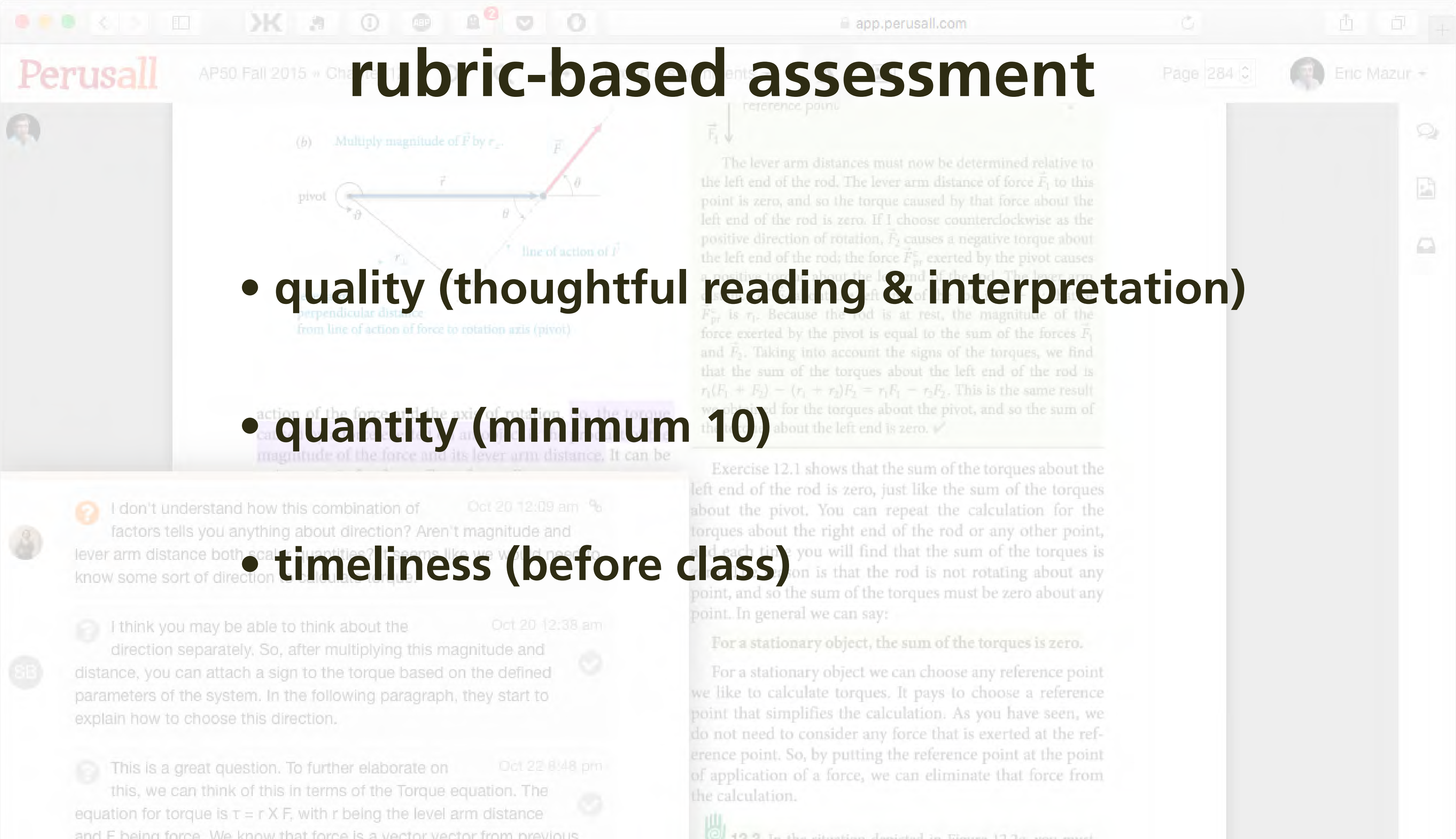
- quality (thoughtful reading & interpretation)



rubric-based assessment

- quality (thoughtful reading & interpretation)
- quantity (minimum 10)





rubric-based assessment

- **quality (thoughtful reading & interpretation)**
- **quantity (minimum 10)**
- **timeliness (before class)**

rubric-based assessment

- quality (thoughtful reading & interpretation)
- quantity (minimum 10)
- timeliness (before class)
- distribution (not clustered)

rubric-based assessment

- quality (thoughtful reading & interpretation)
- quantity (minimum 10)
- timeliness (before class)
- distribution (not clustered)

over 20,000 annotations!

rubric-based assessment

- quality (thoughtful reading & interpretation)
- quantity (minimum 10)
- timeliness (before class)
- distribution (not clustered)

how do you process all of that??

rubric-based assessment

- quality (thoughtful reading & interpretation)
- quantity (minimum 10)
- timeliness (before class)
- distribution (not clustered)

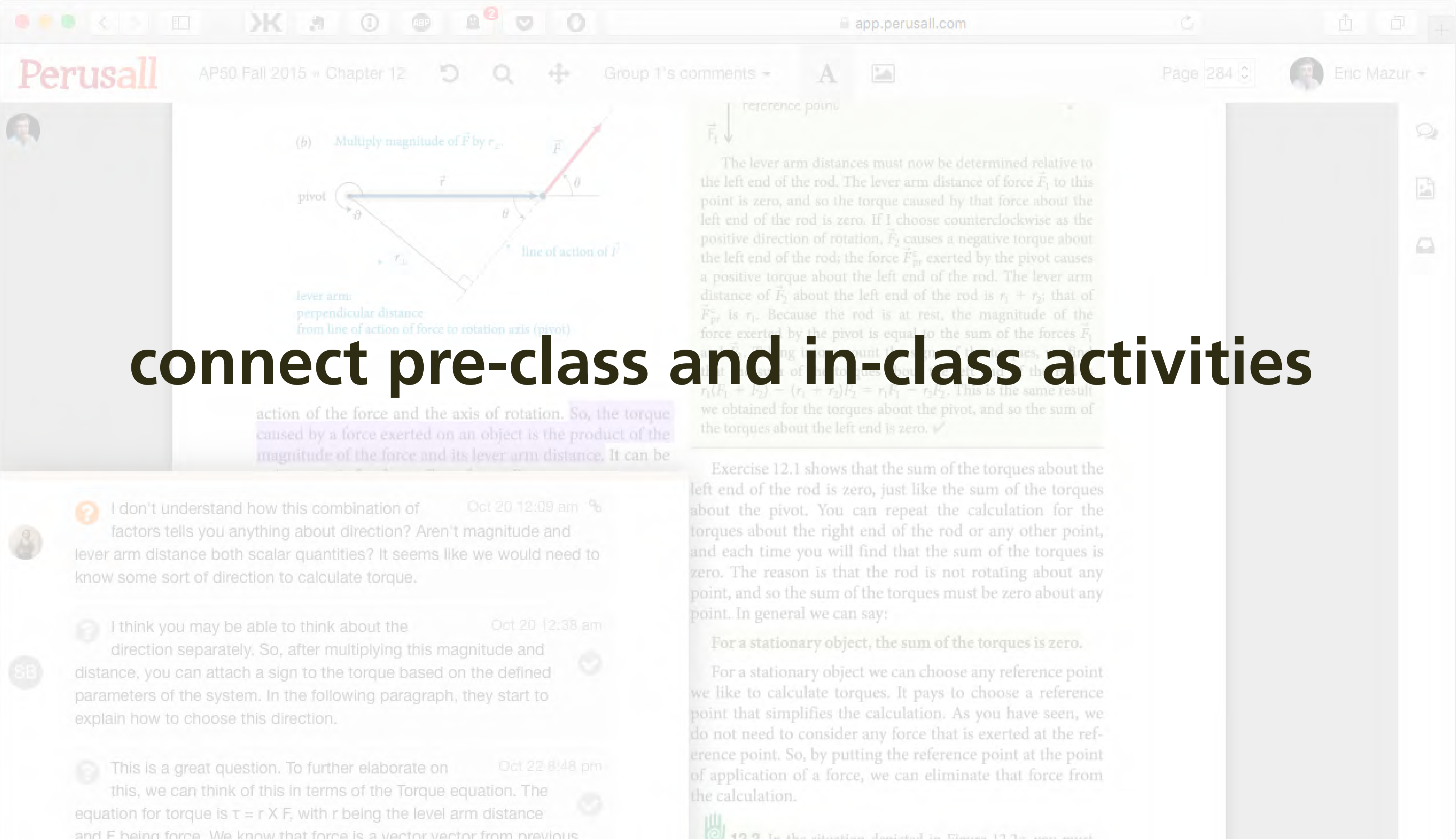
how do you process all of that??

fully automated assessment

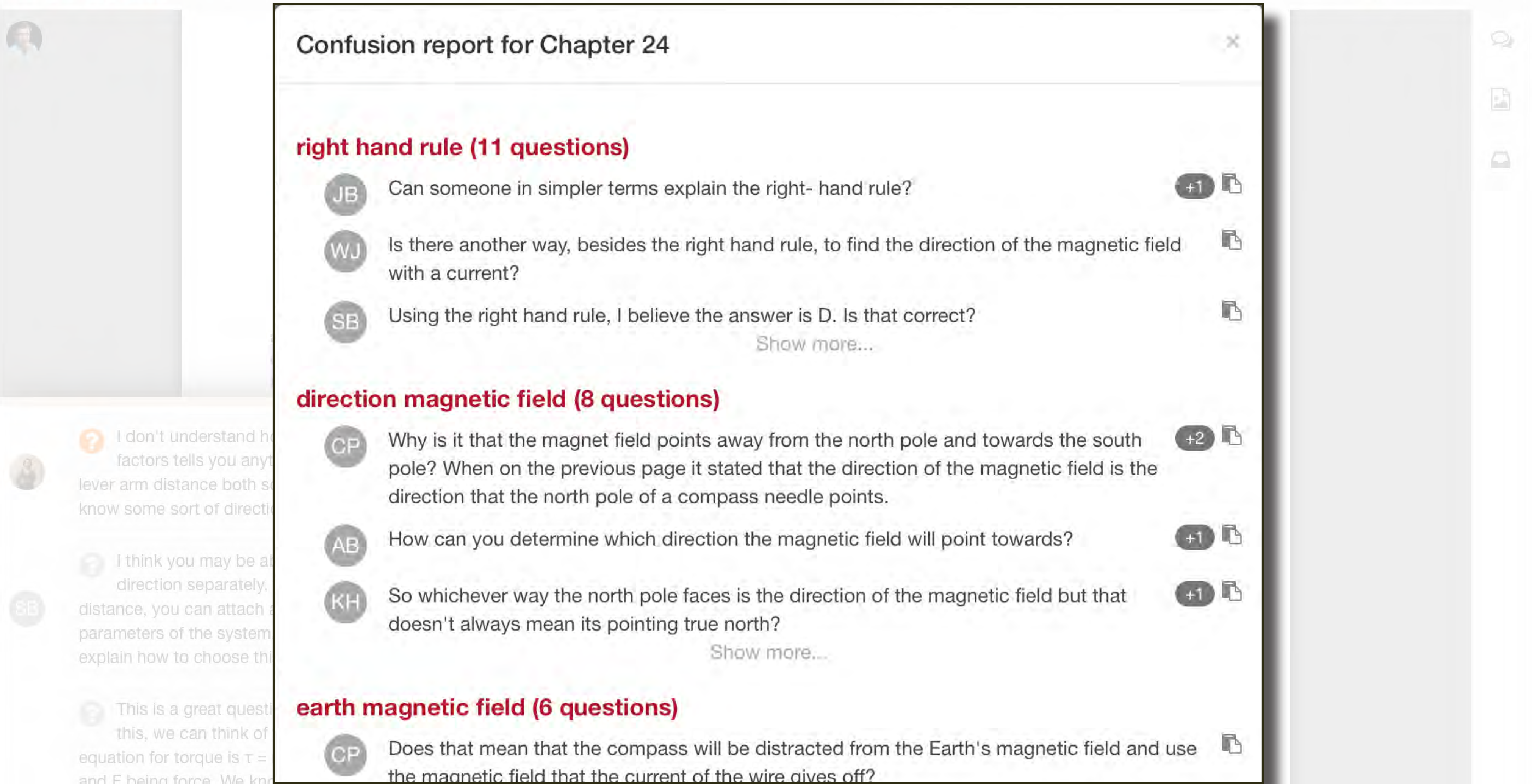
fully automated assessment

- specialized machine learning algorithm
- assesses intellectual content
- exceeds intercoder reliability

connect pre-class and in-class activities



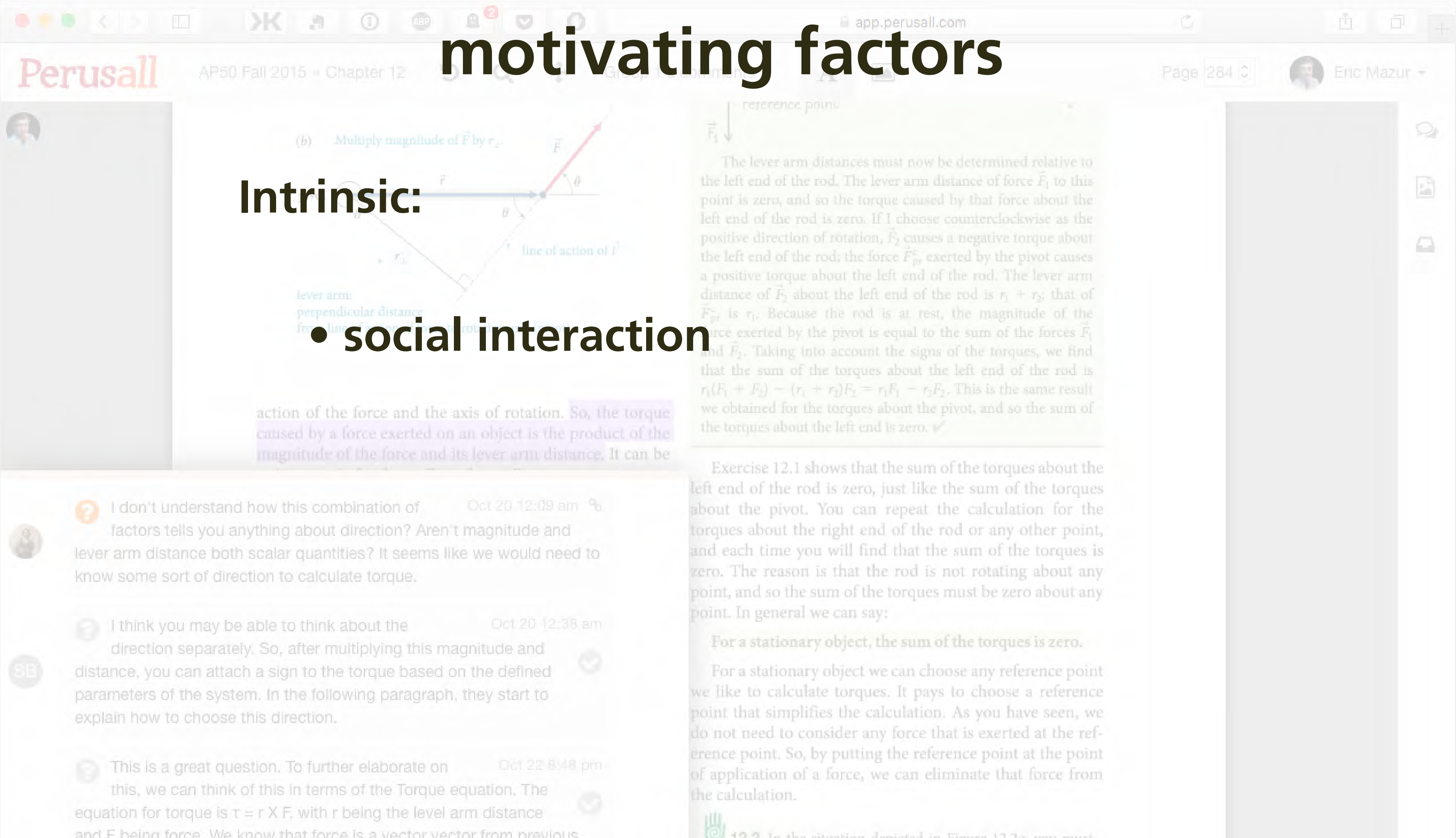
confusion report



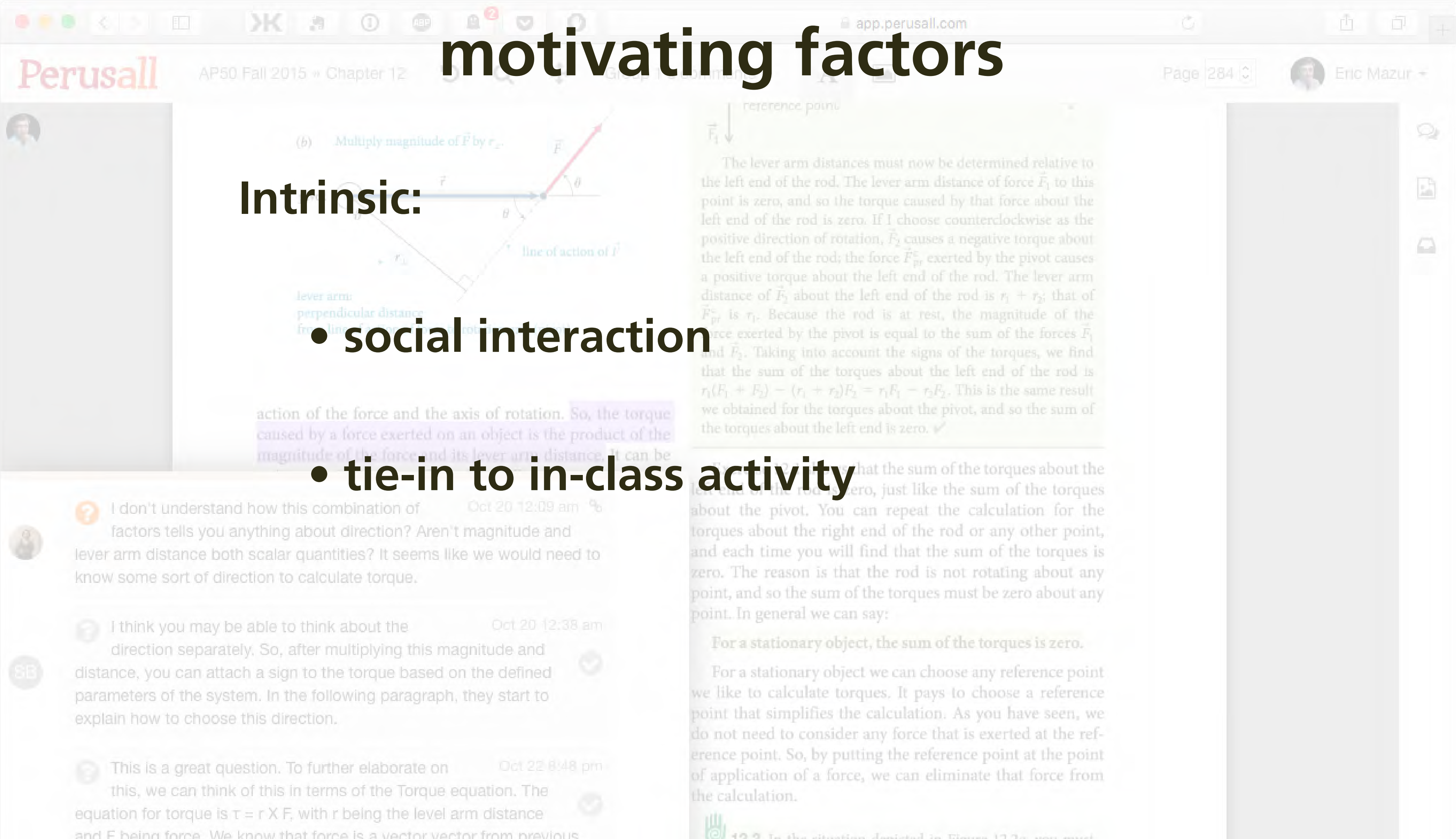
motivating factors

Intrinsic:

- social interaction



motivating factors



Intrinsic:

- social interaction
- tie-in to in-class activity

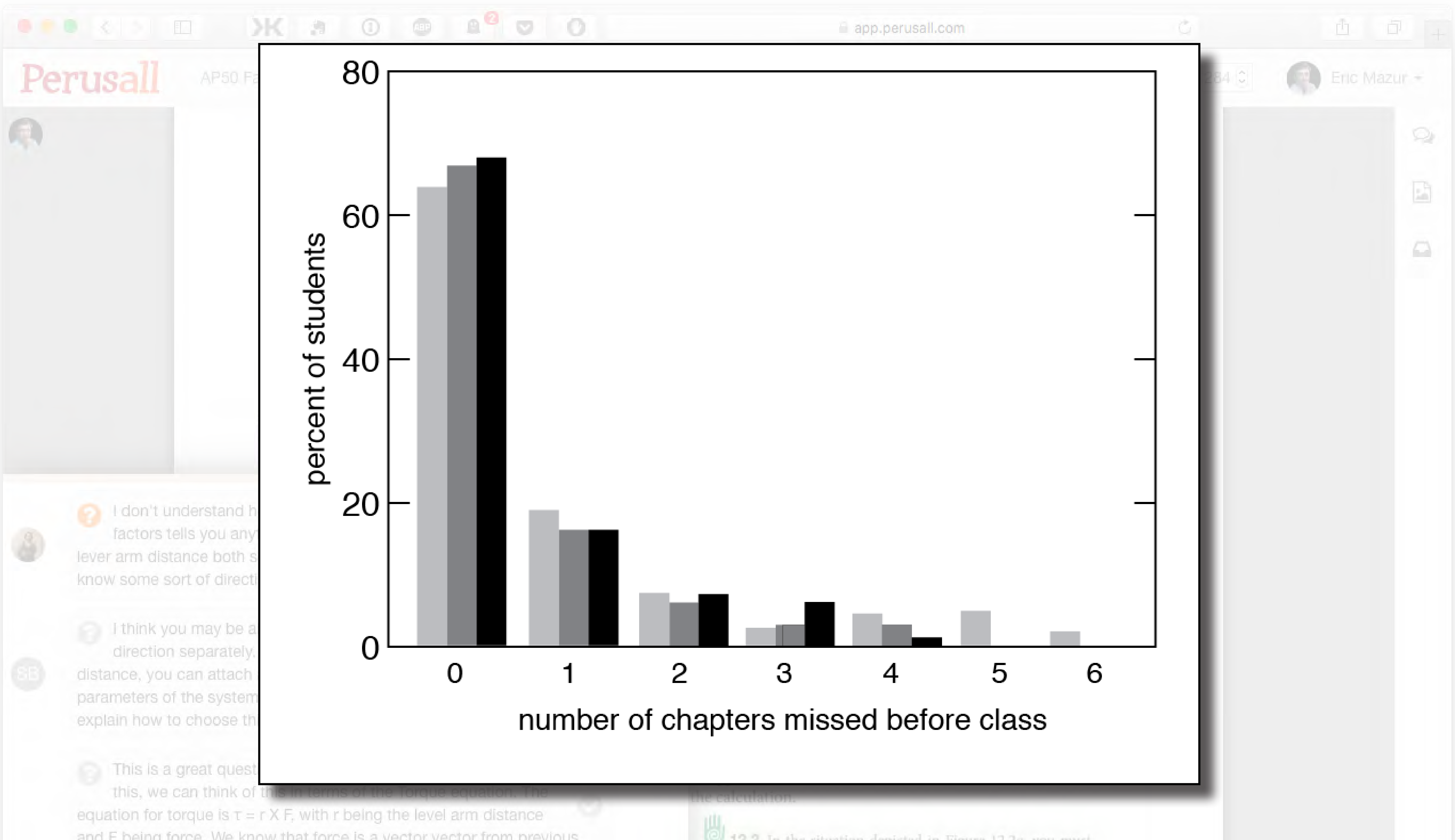
motivating factors

Intrinsic:

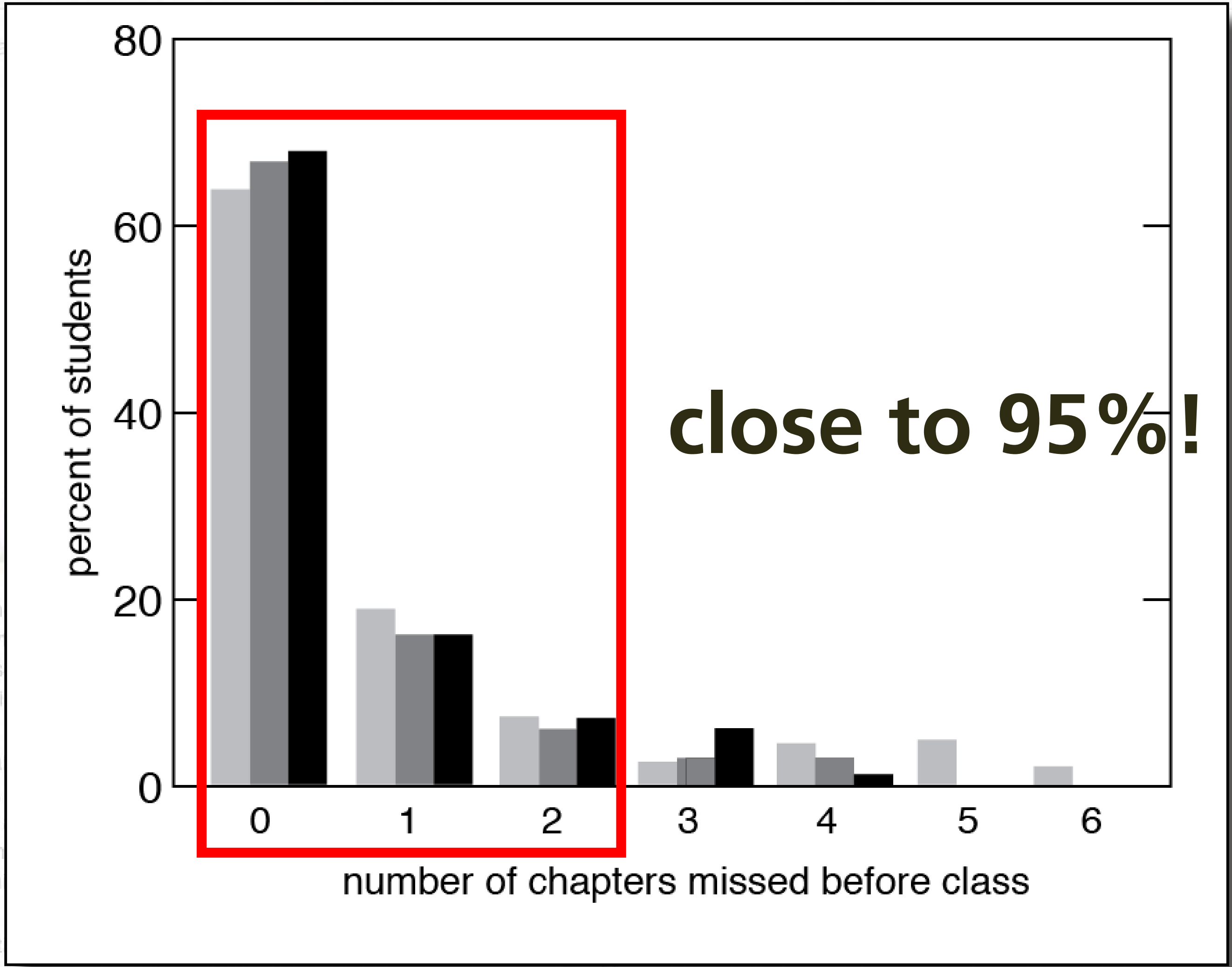
- social interaction
- tie-in to in-class activity

Extrinsic:

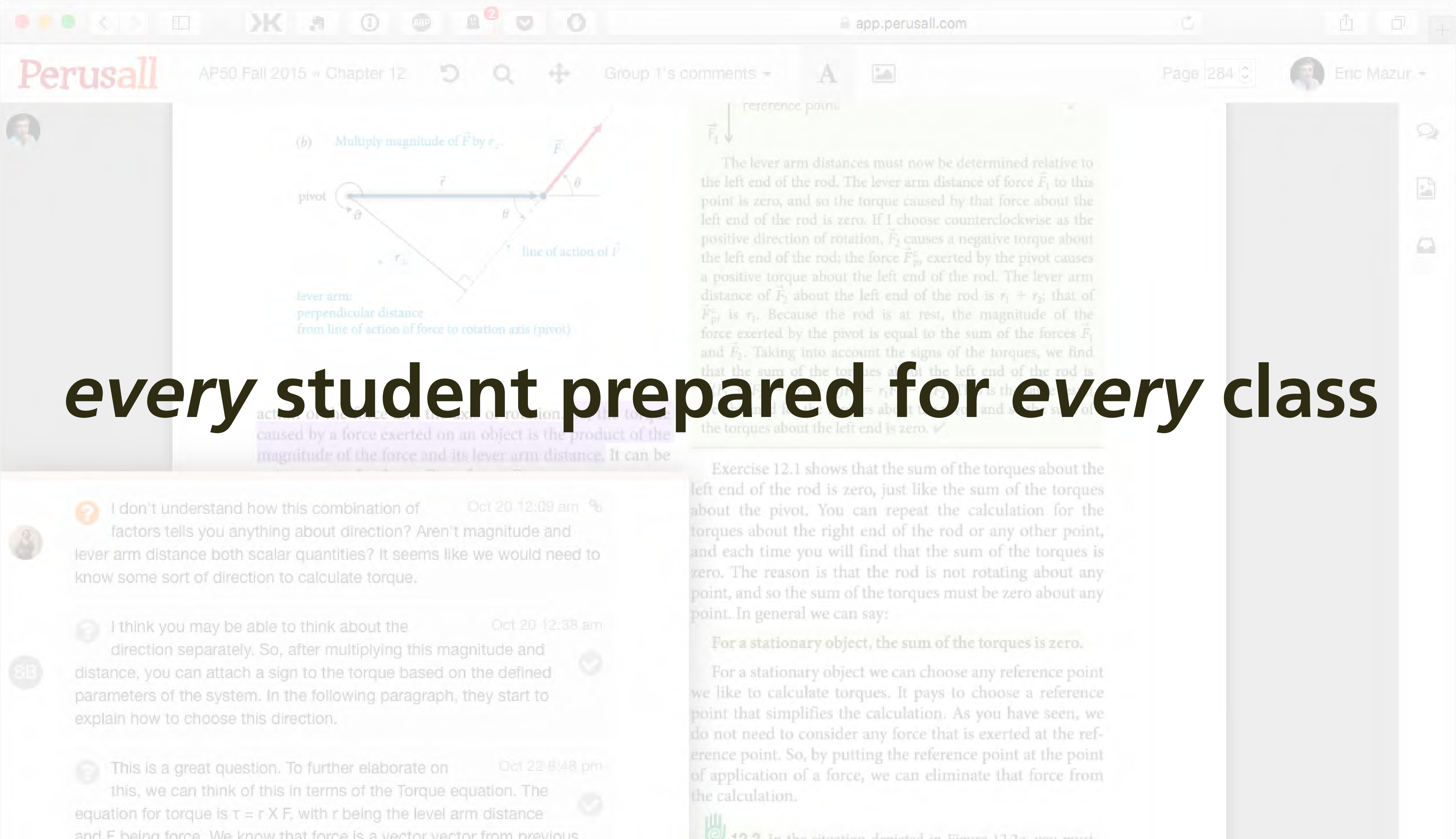
- assessment (fully automated)



80
60
40
20
0
percent of students
0
1
2
3
4
5
6
number of chapters missed before class


80
60
40
20
0
percent of students
0
1
2
3
4
5
6
number of chapters missed before class
close to 95%!

every student prepared for *every* class



Benefits

- virtually 100% completion of assignments
- improved use of class time

Benefits

- **virtually 100% completion of assignments**
- **improved use of class time**

all at no cost & without additional instructor effort!

Education is not just about:

- transferring information
- getting students to do what we do

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active participation/social interaction a must!

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