The Tyranny of the Lecture

Pontificia Universidad Católica de Chile
Santiago, Chile, 12 January 2016

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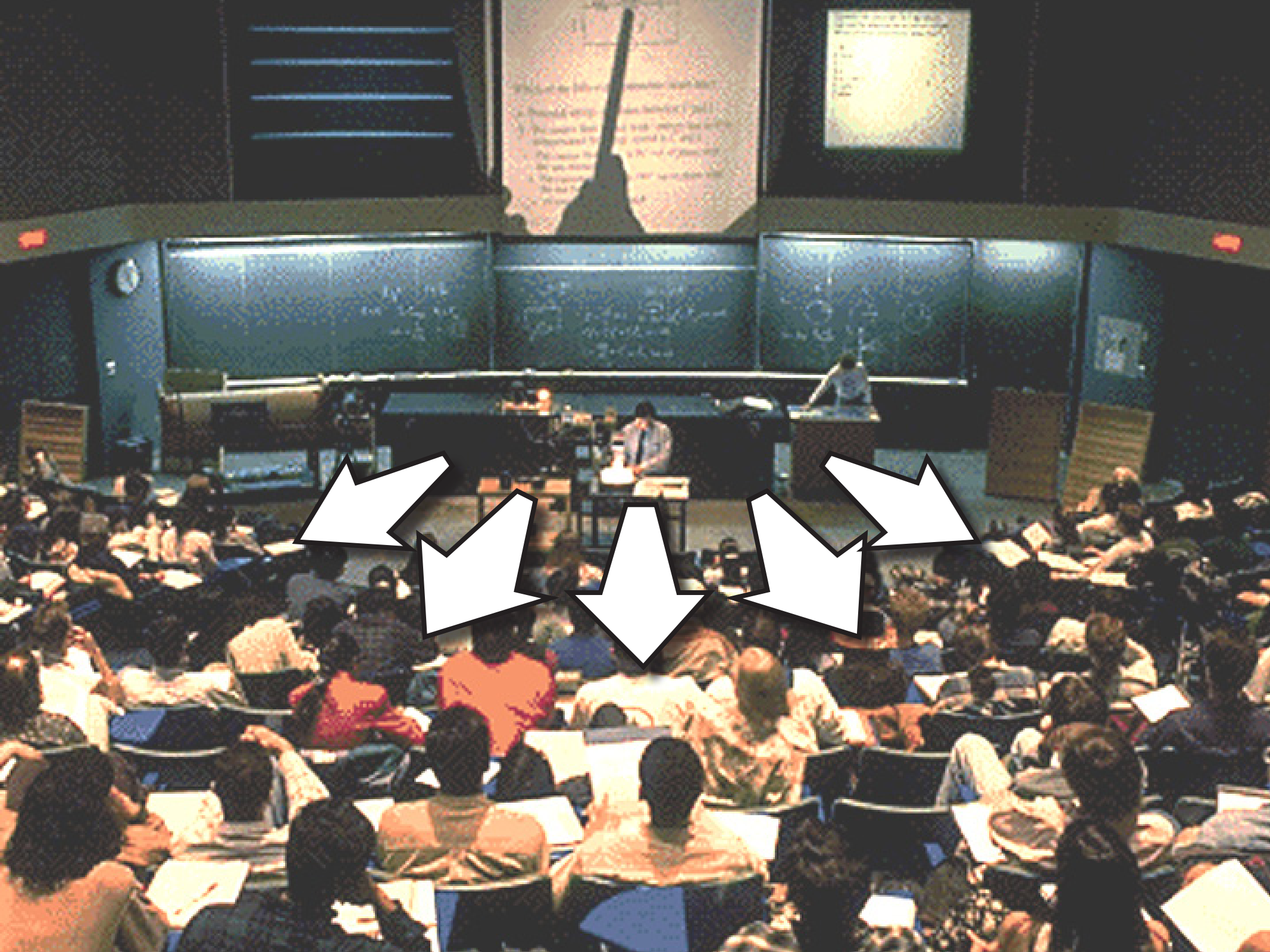


an illusion. . .

1. transfer of information

1. transfer of information

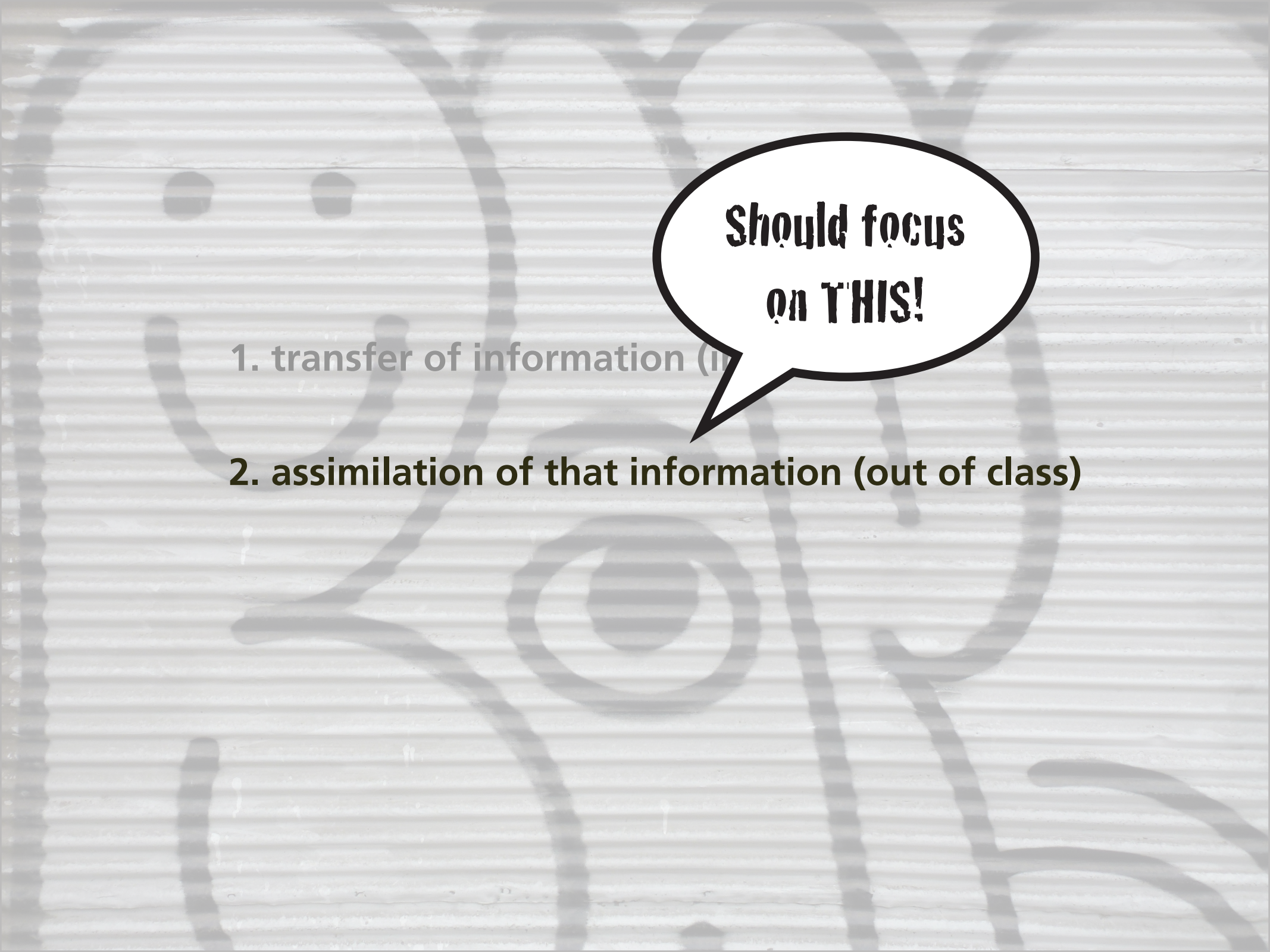
2. assimilation of that information

1. transfer of information (in class)

2. assimilation of that information

1. transfer of information (in class)

2. assimilation of that information (out of class)


Should focus
on THIS!
1. transfer of information (i
2. assimilation of that information (out of class)

1. transfer of information (in class)

2. assimilation of that information (out of class)

1. transfer of information (out of class)

2. assimilation of that information (in class)

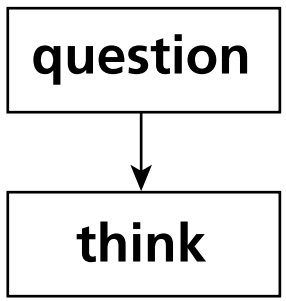
peer

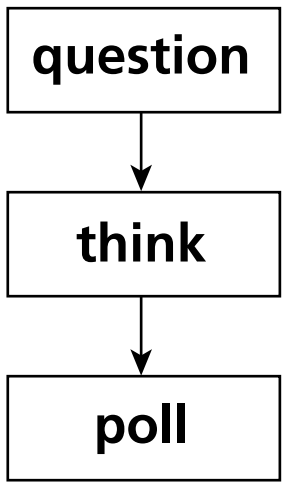
1. transfer of information (out of class)

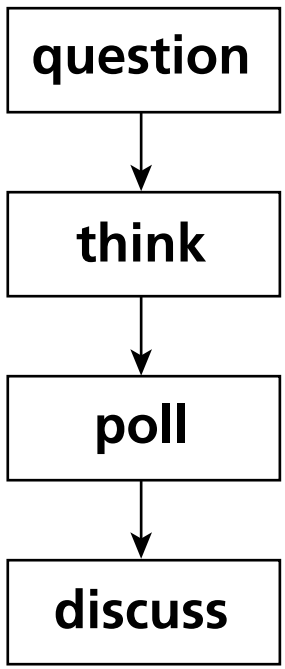
2. assimilation of that information (in class)

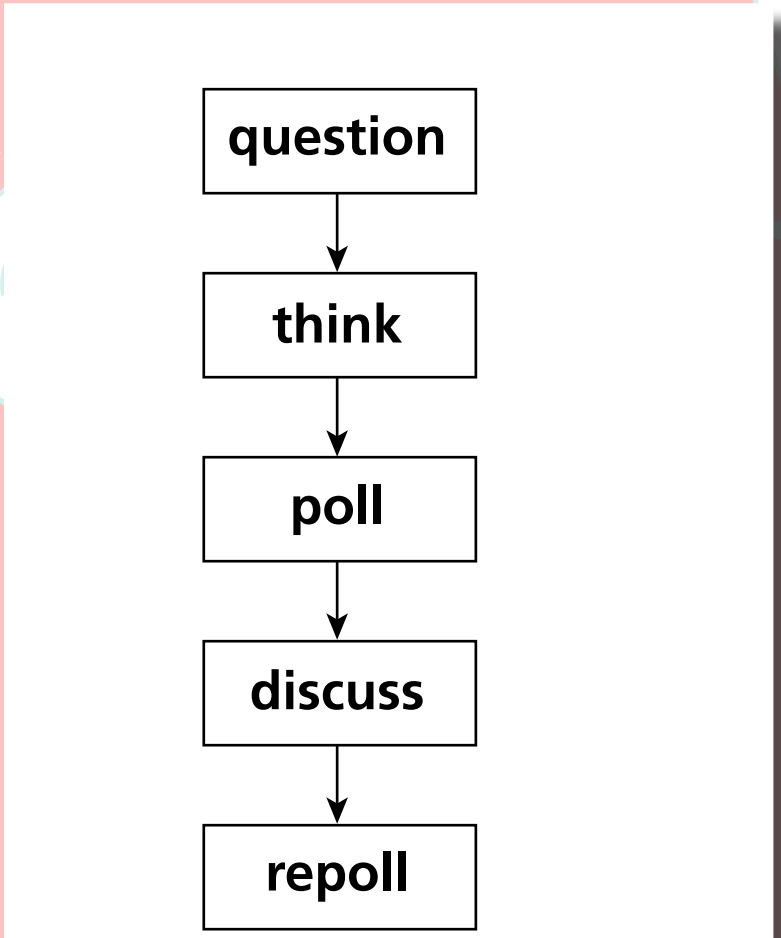
INSTRUCTION

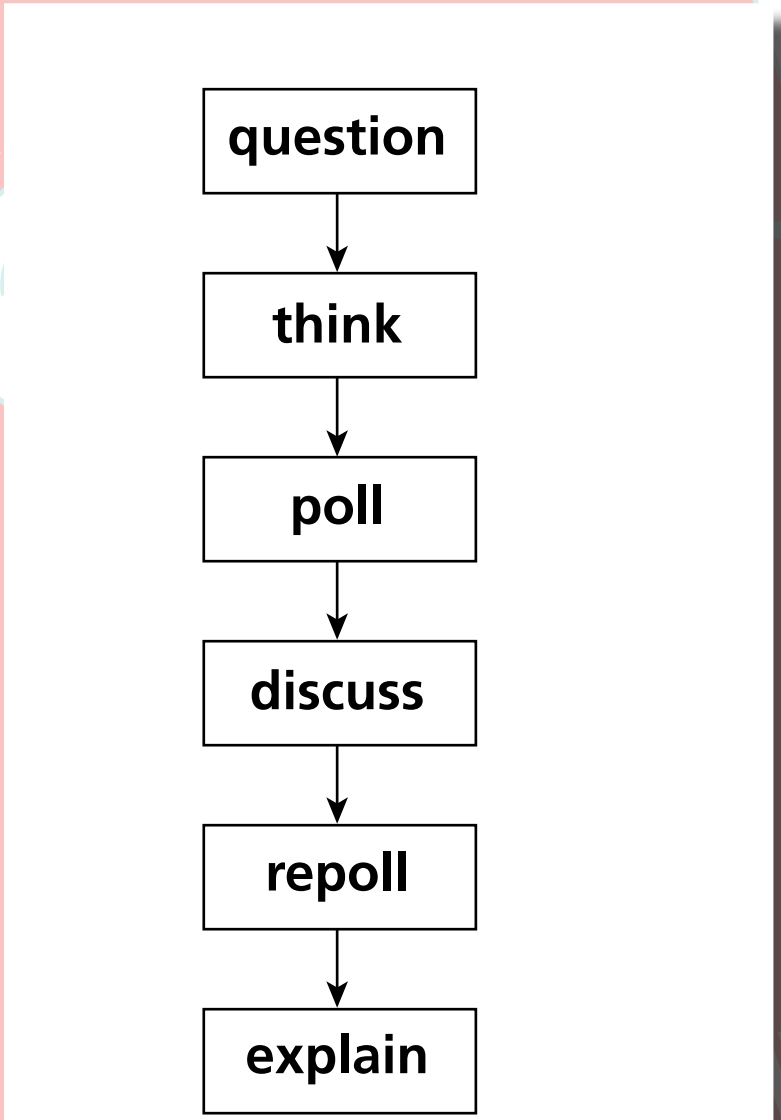
question

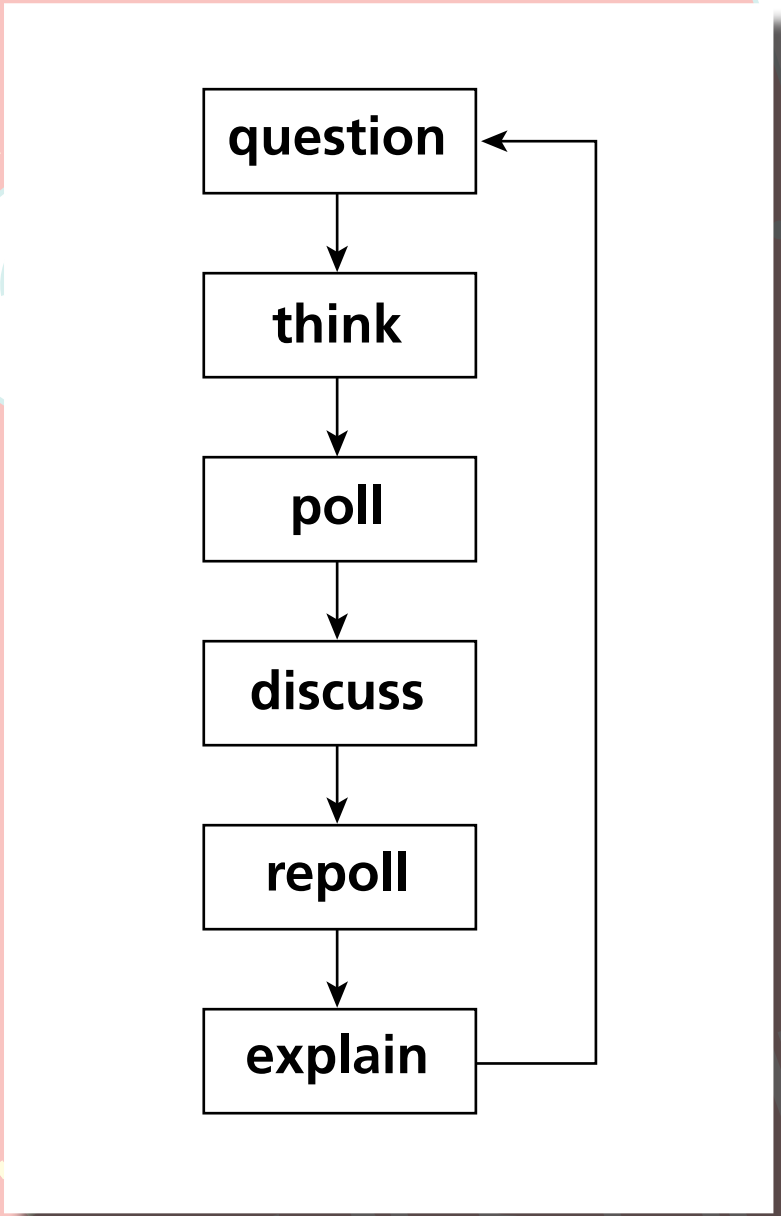

question
think

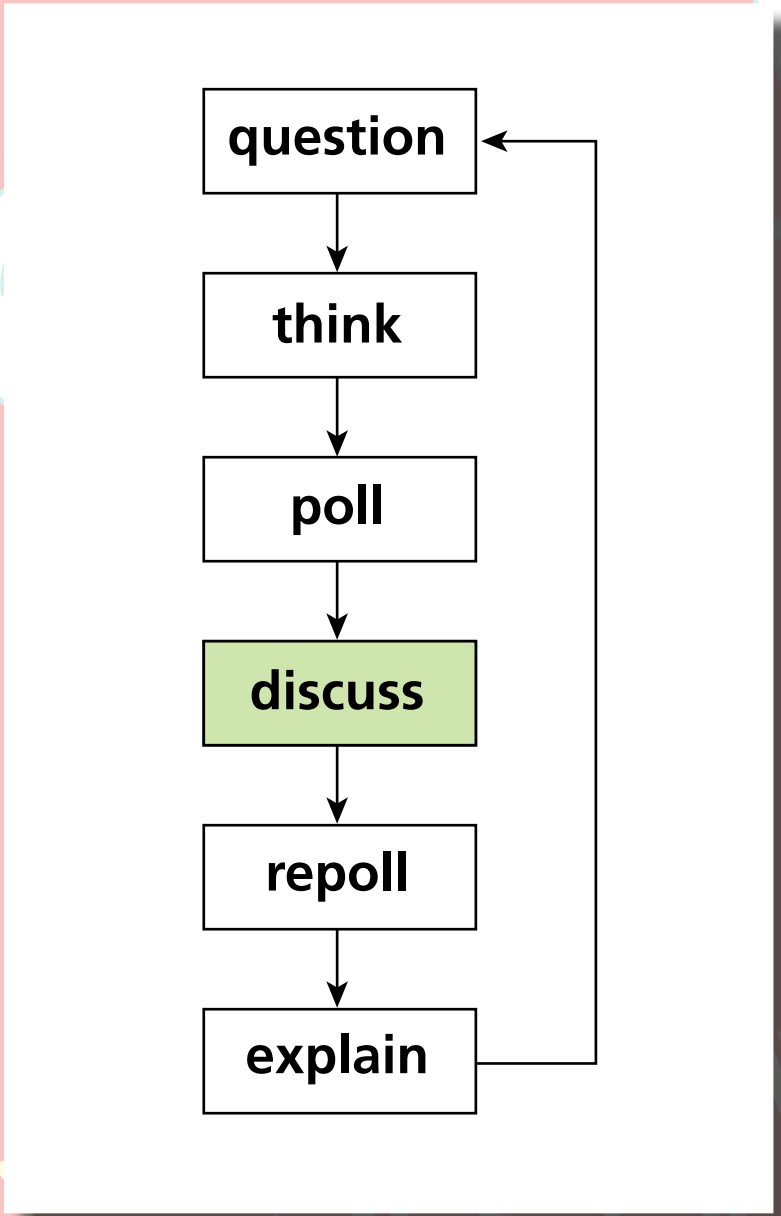

question
think
poll


question
think
poll
discuss


question
think
poll
discuss
repoll


question
think
poll
discuss
repoll
explain


question
think
poll
discuss
repoll
explain


question
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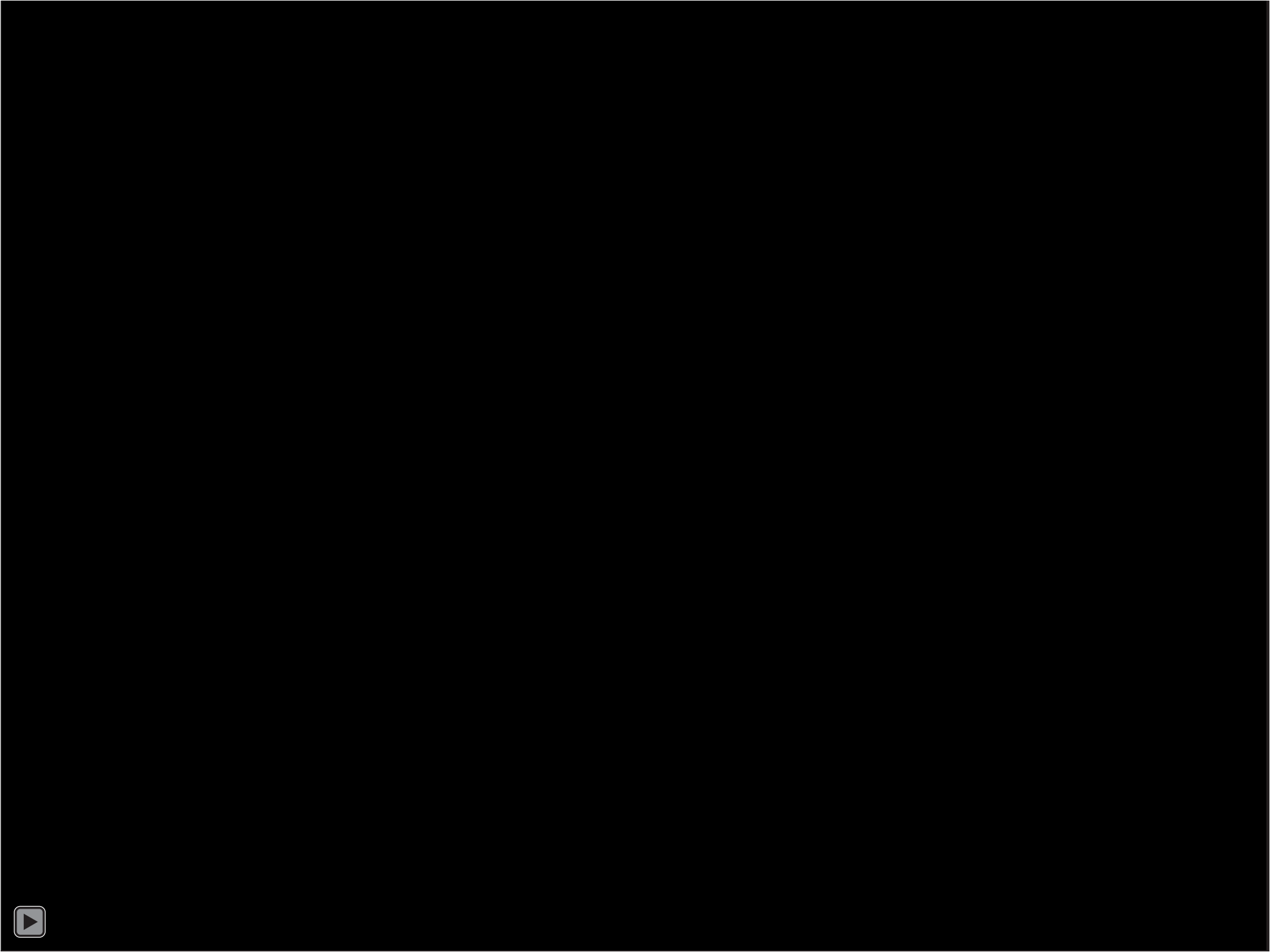
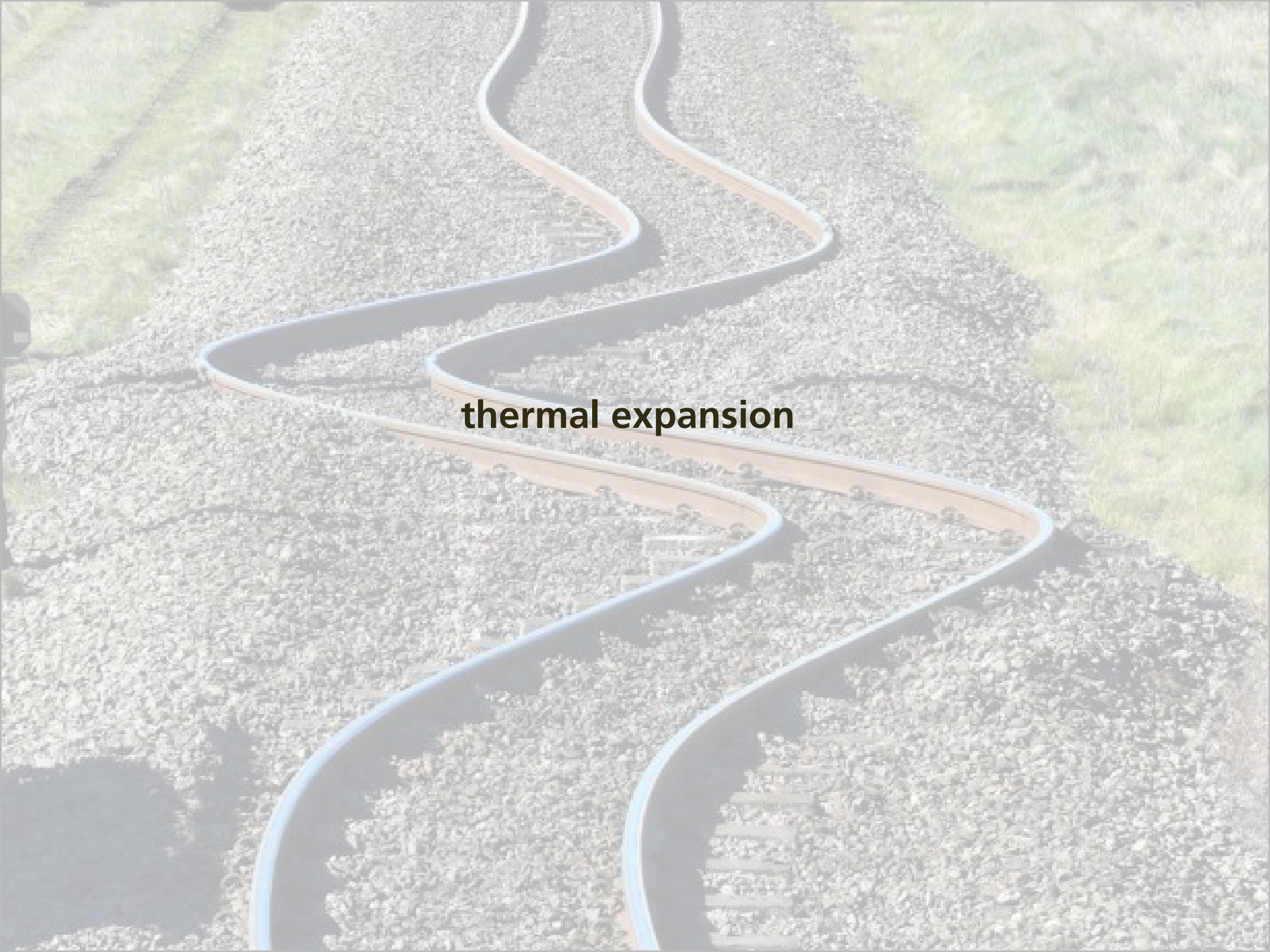
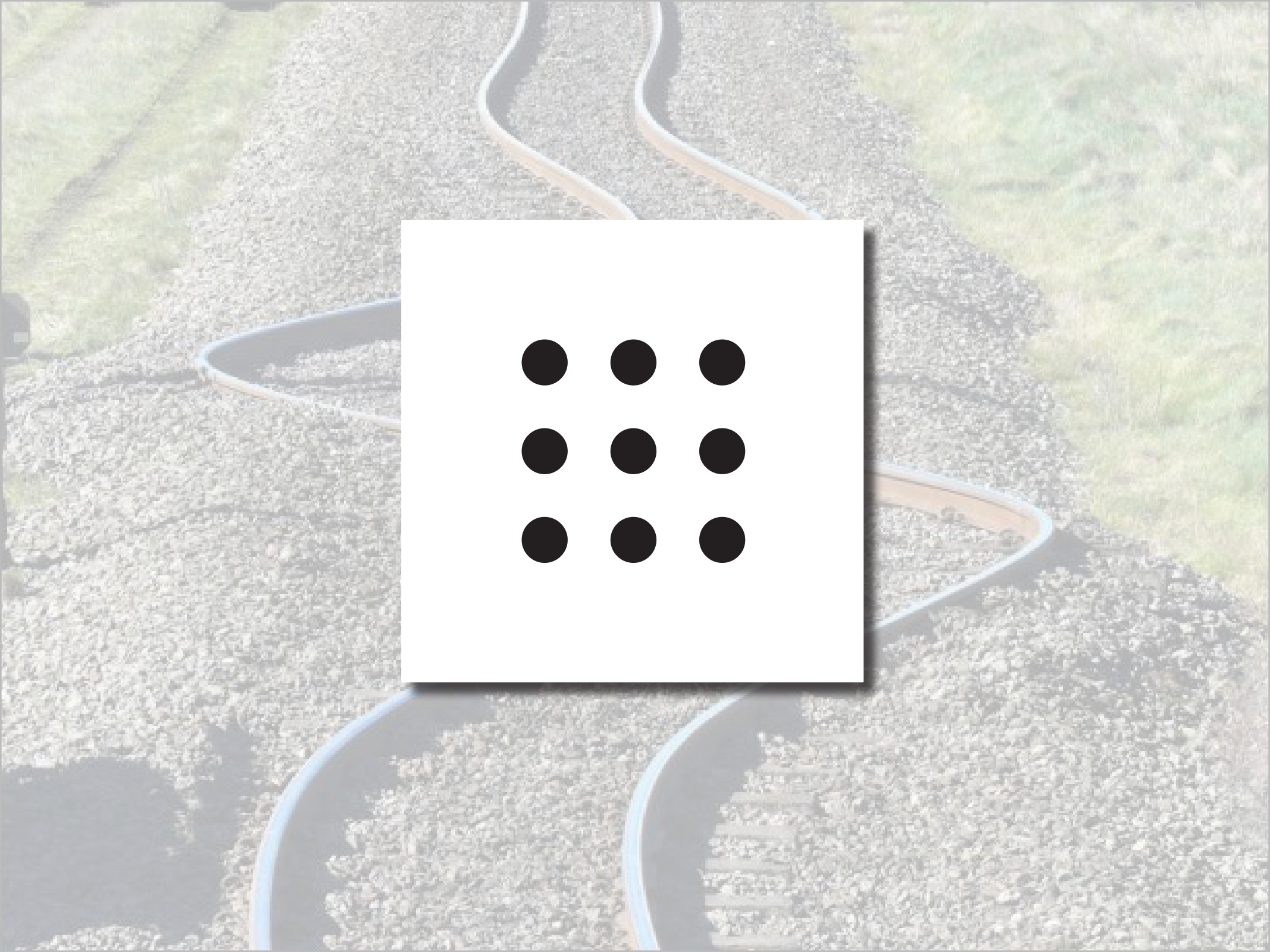
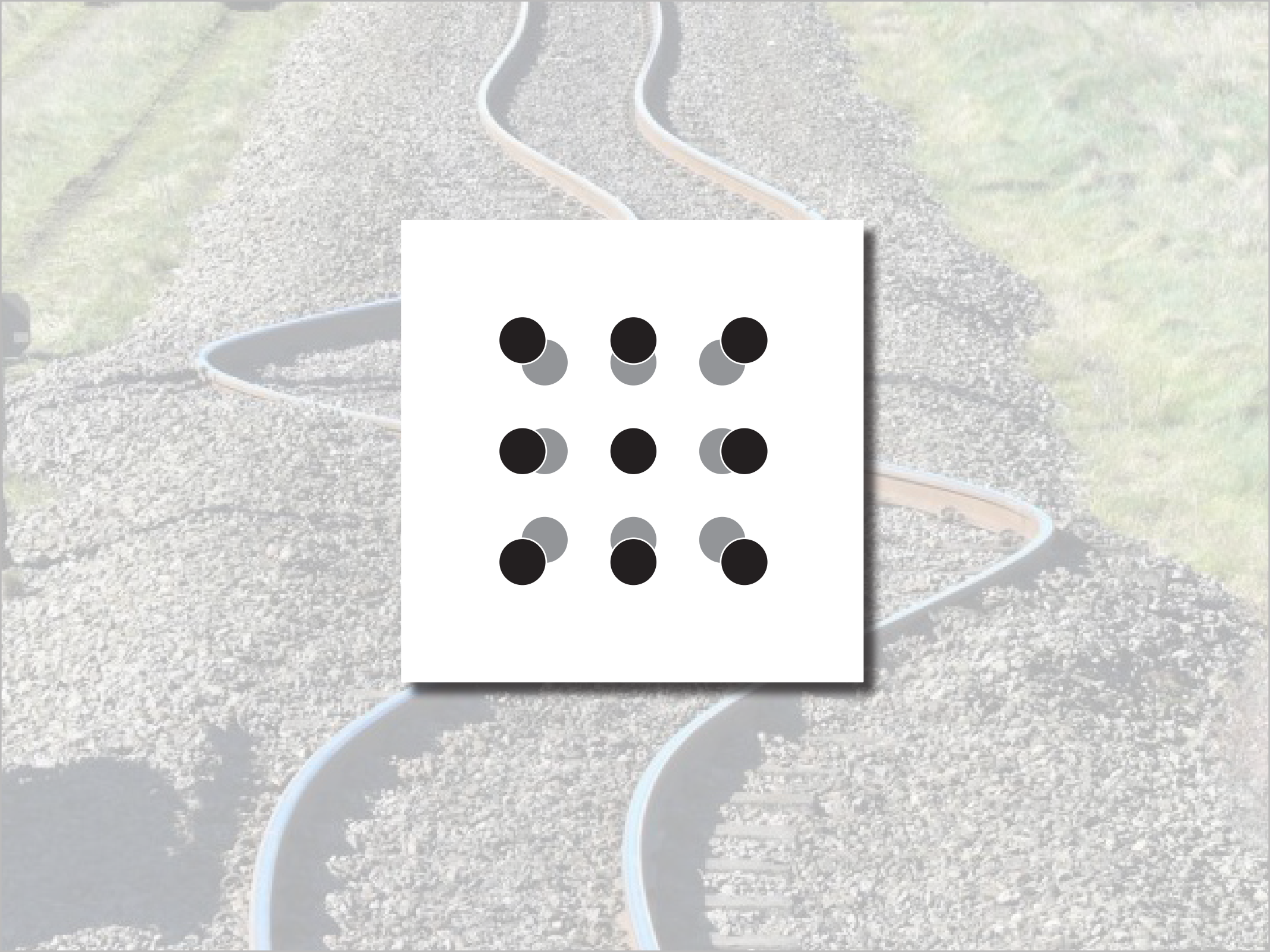


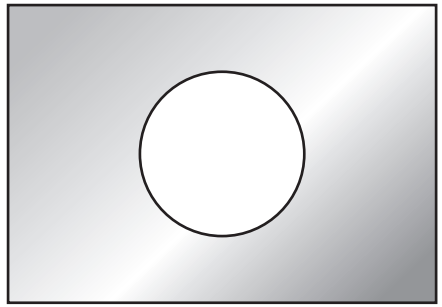

thermal expansion





all of them

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



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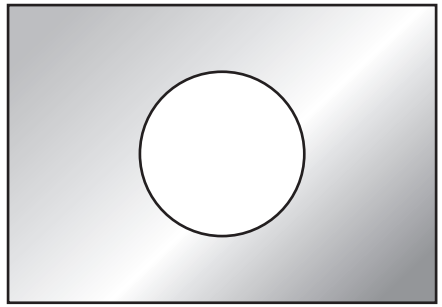
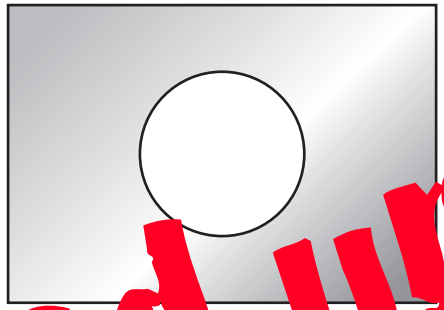


When the plate is uniformly heated, the diameter of the hole

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

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

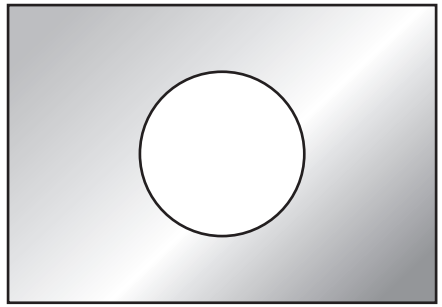


When the plate is uniformly heated, the diameter of the hole

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

you got all fired up!

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



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

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

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…

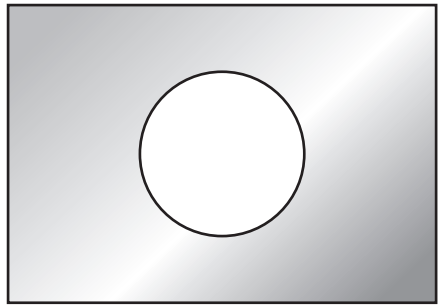
1. made a commitment
2. externalized your answer
3. moved from the answer/fact to reasoning

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

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



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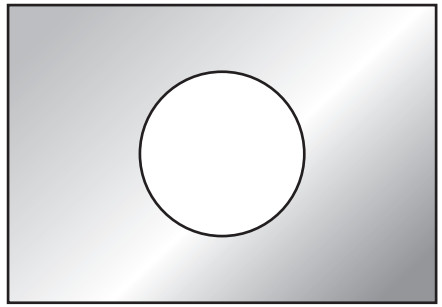
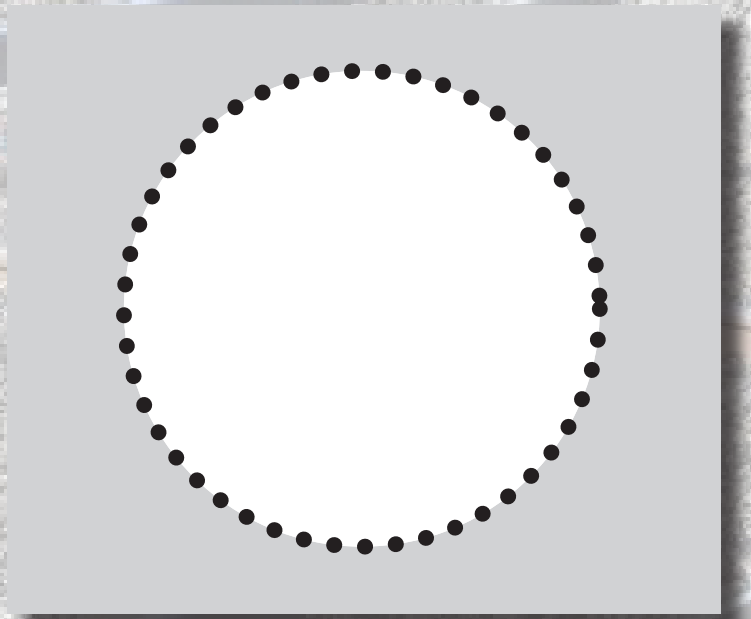


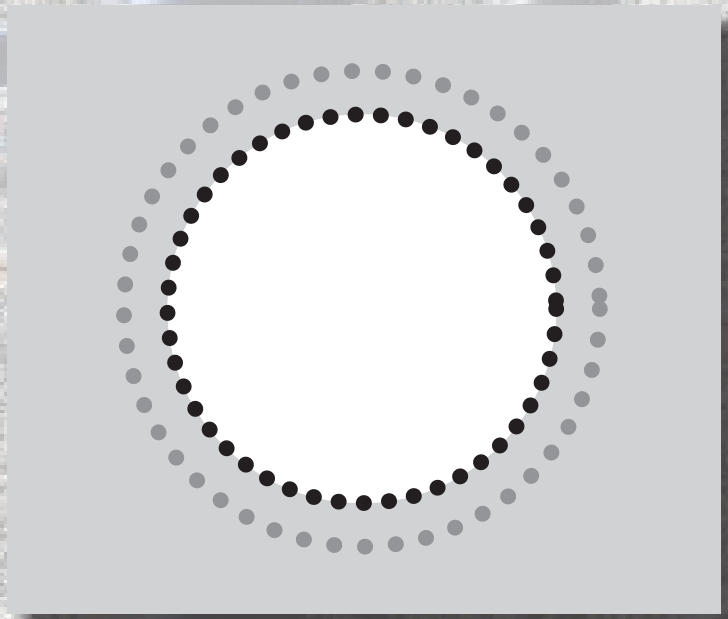
When the plate is uniformly heated, the diameter of the hole

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

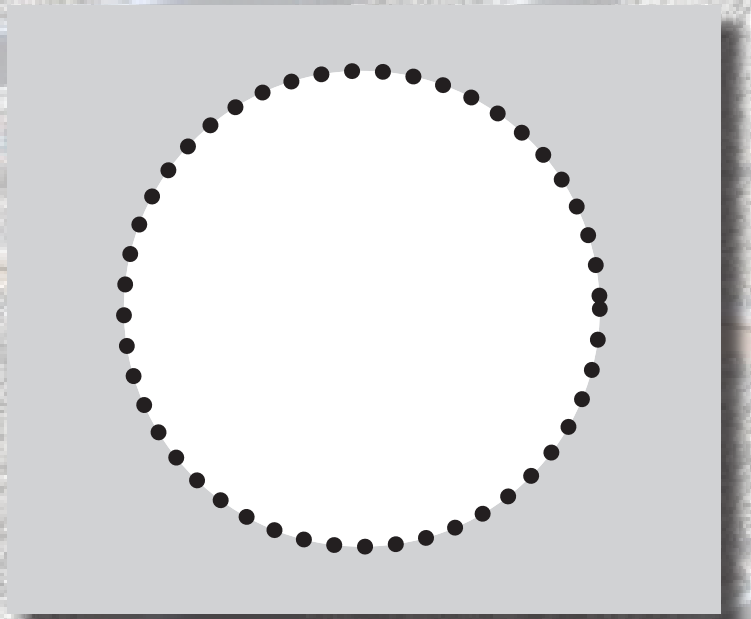
consider atoms at rim of hole



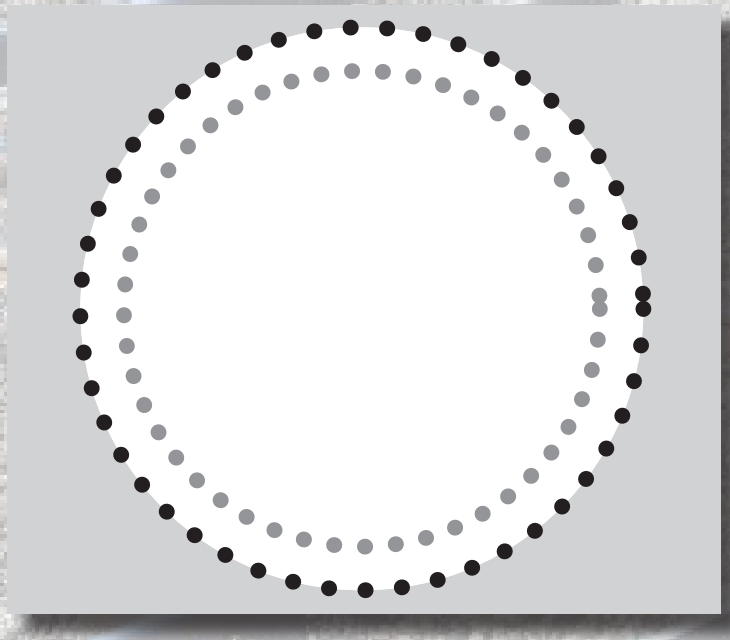
consider atoms at rim of hole



consider atoms at rim of hole



consider atoms at rim of hole



consider atoms at rim of hole

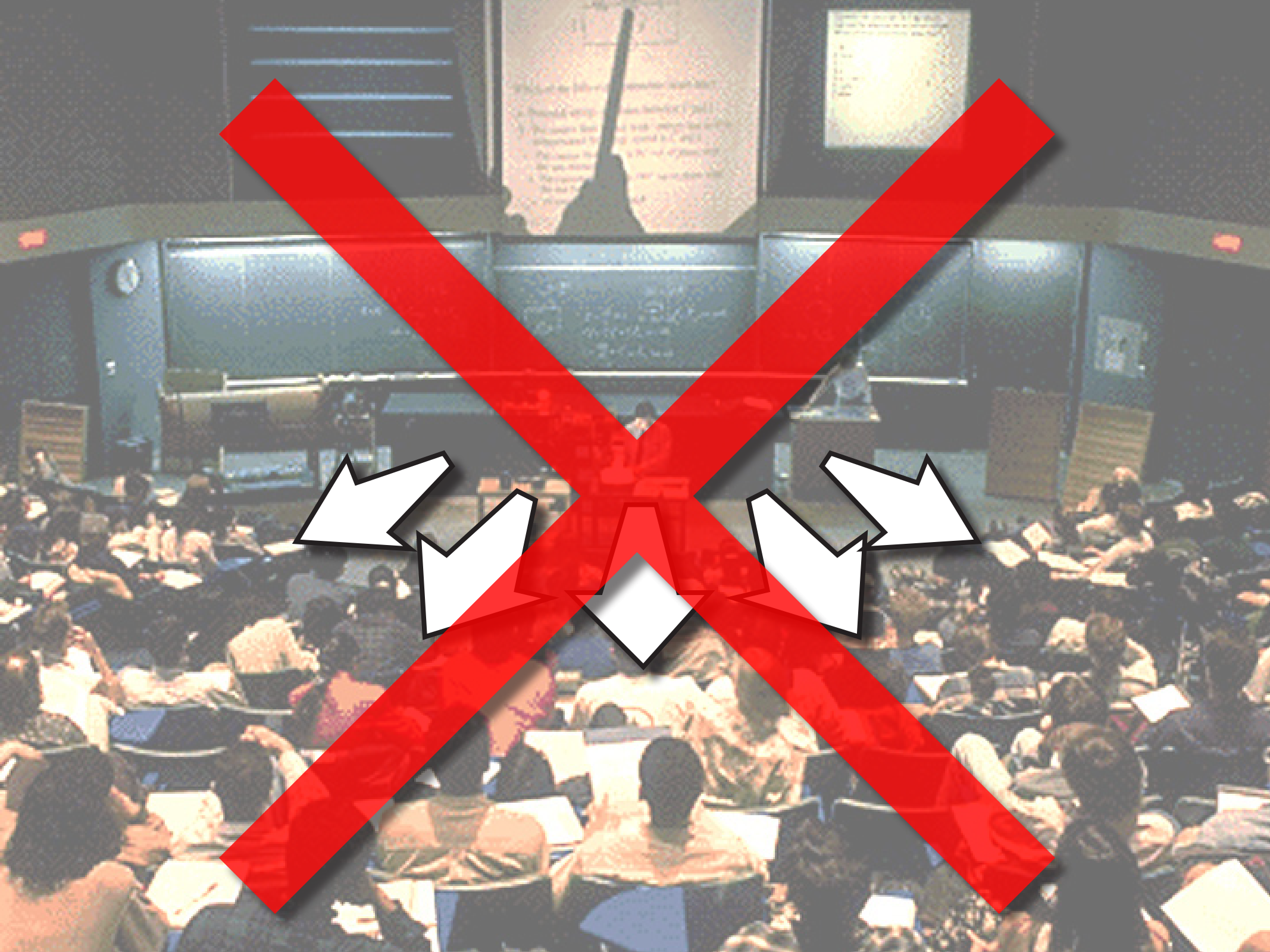
peer

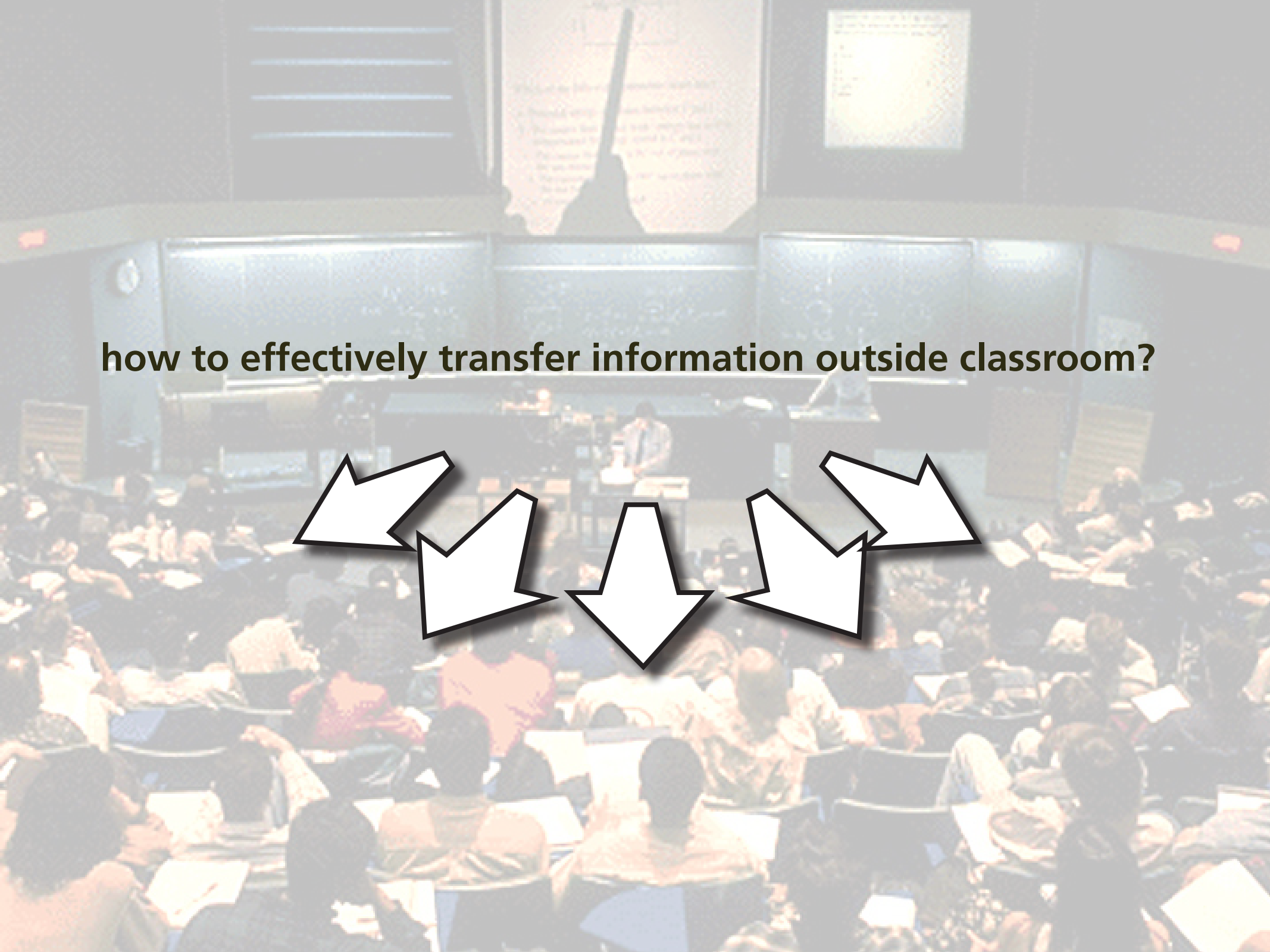
back to pi

INSTRUCTION

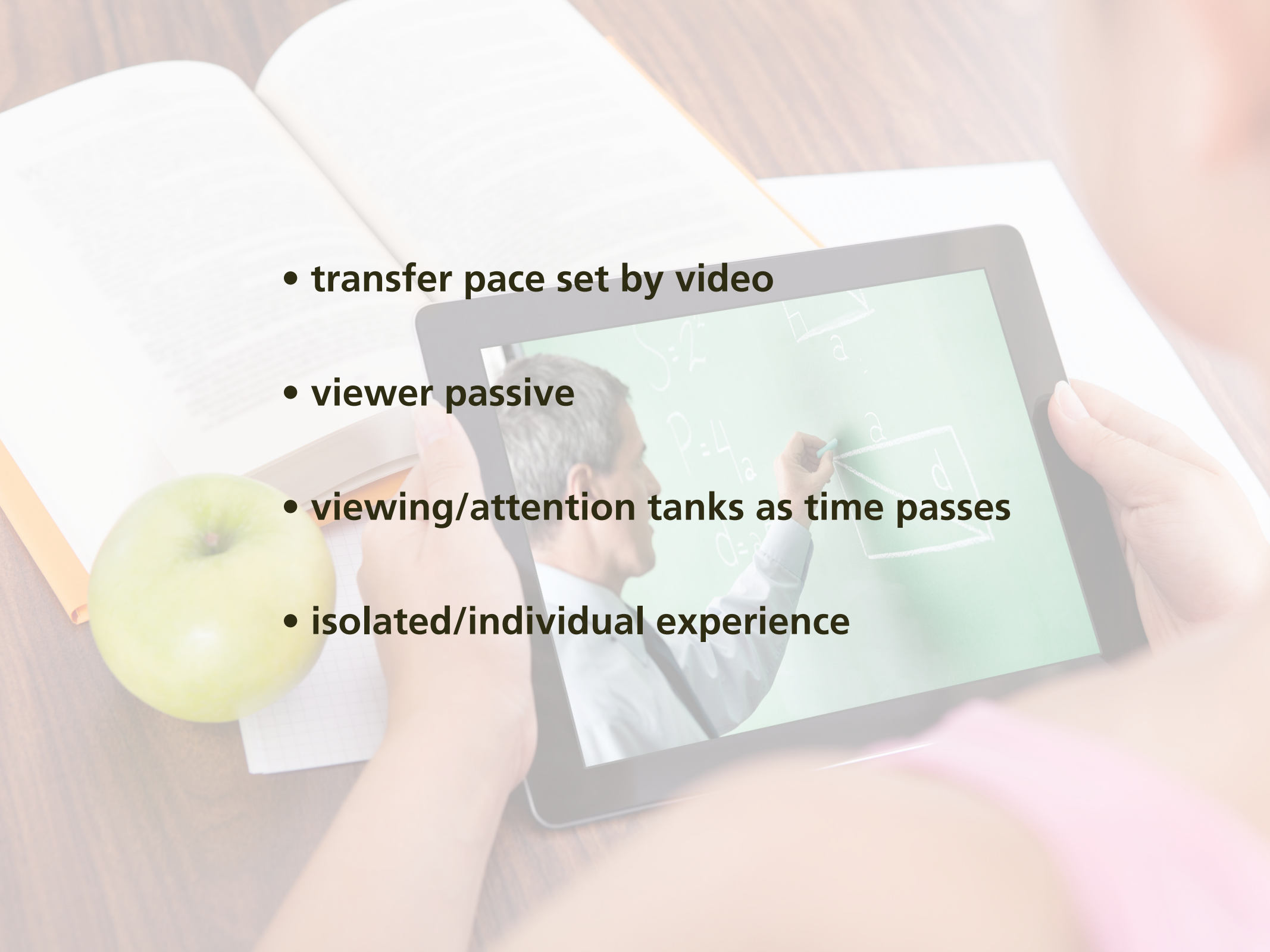
Peer
Higher learning gains
INSTRUCTION

Peer
Higher learning gains
Better retention
INSTRUCTION




how to effectively transfer information outside classroom?

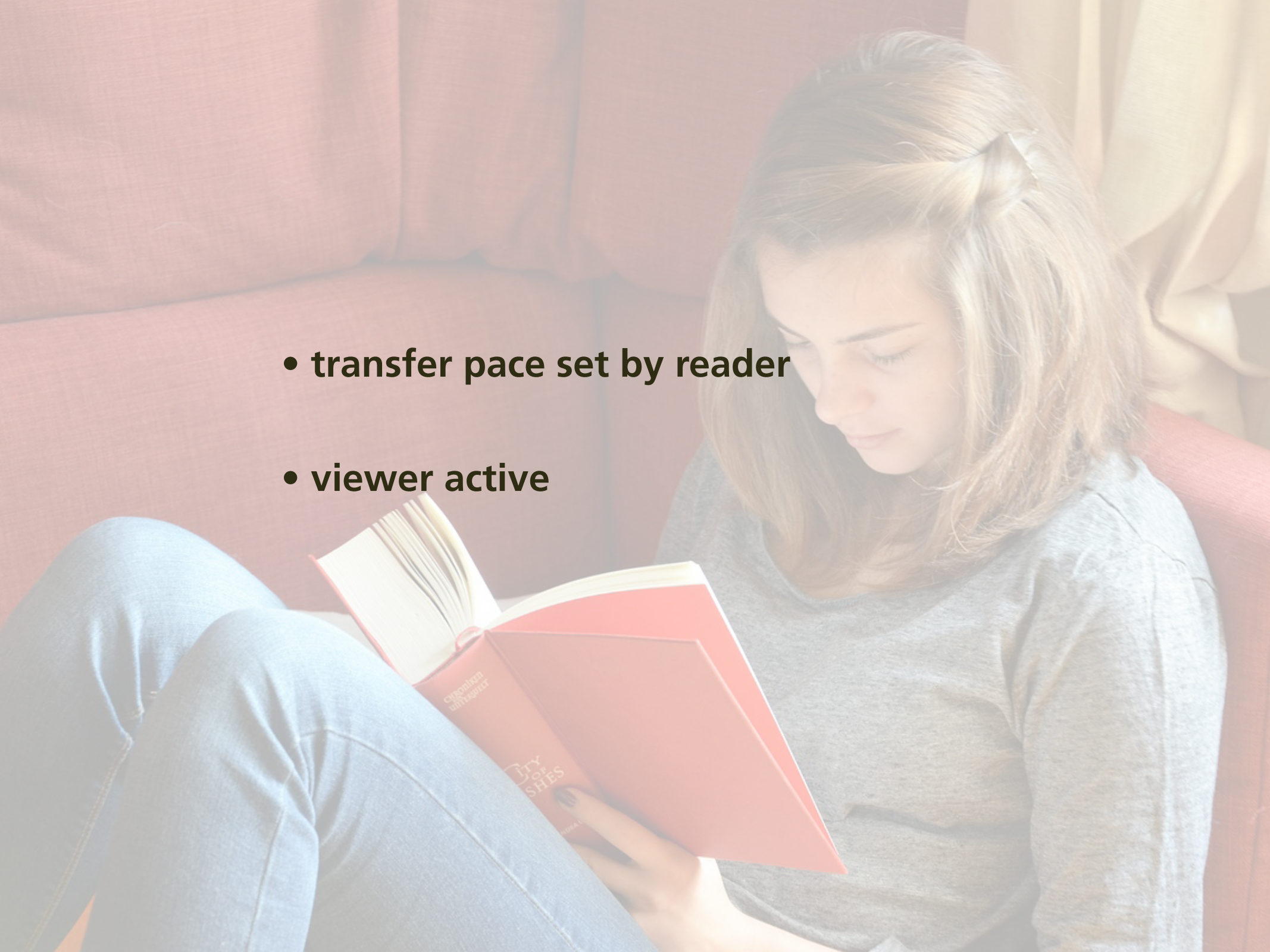
but...



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

we’re simply moving this outside classroom!

CASSANDRA CLARE
CHRONICLES OF THE UNDERWORLD
CITY OF ASHES

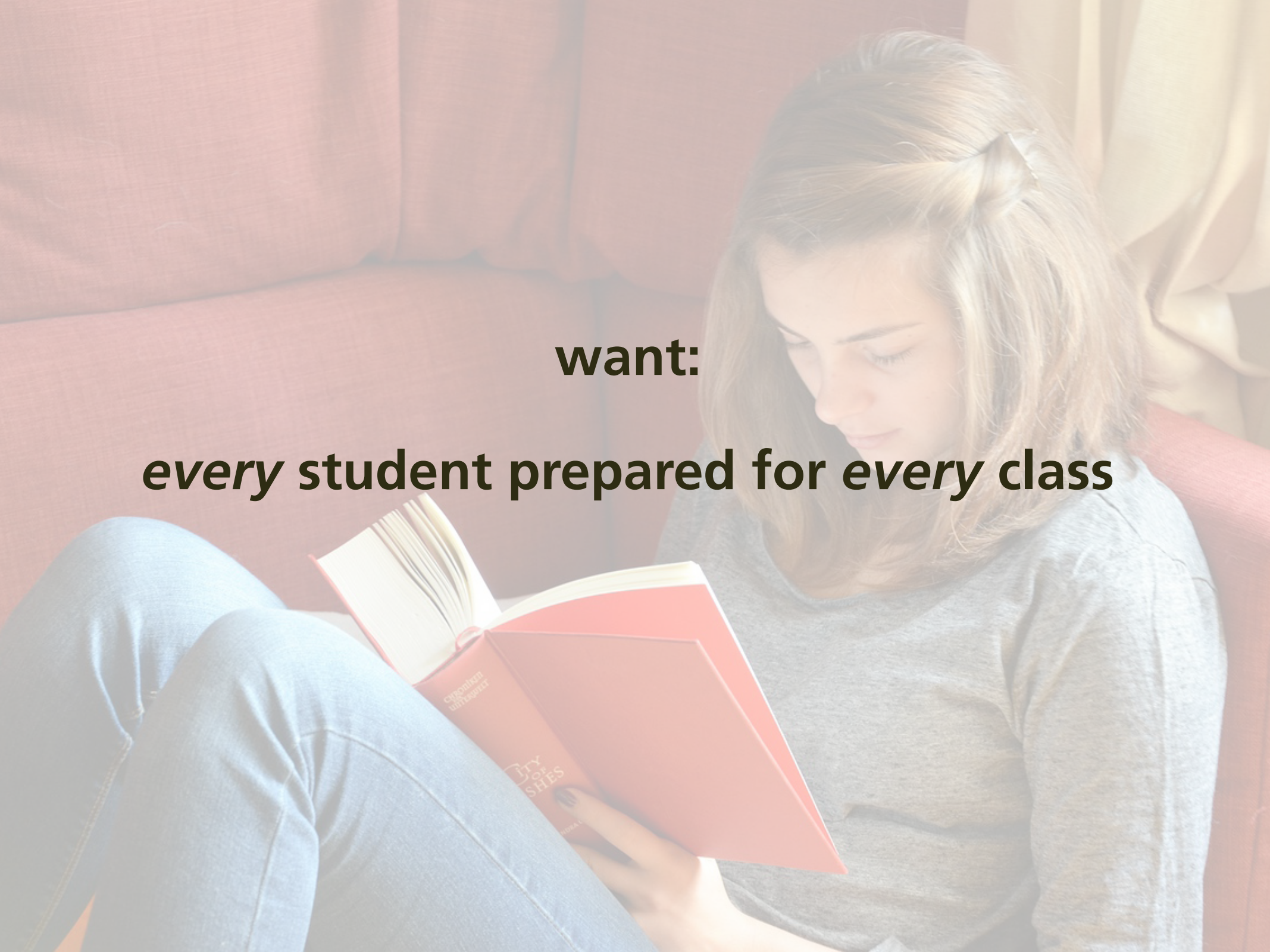


- transfer pace set by reader
- viewer active

but…

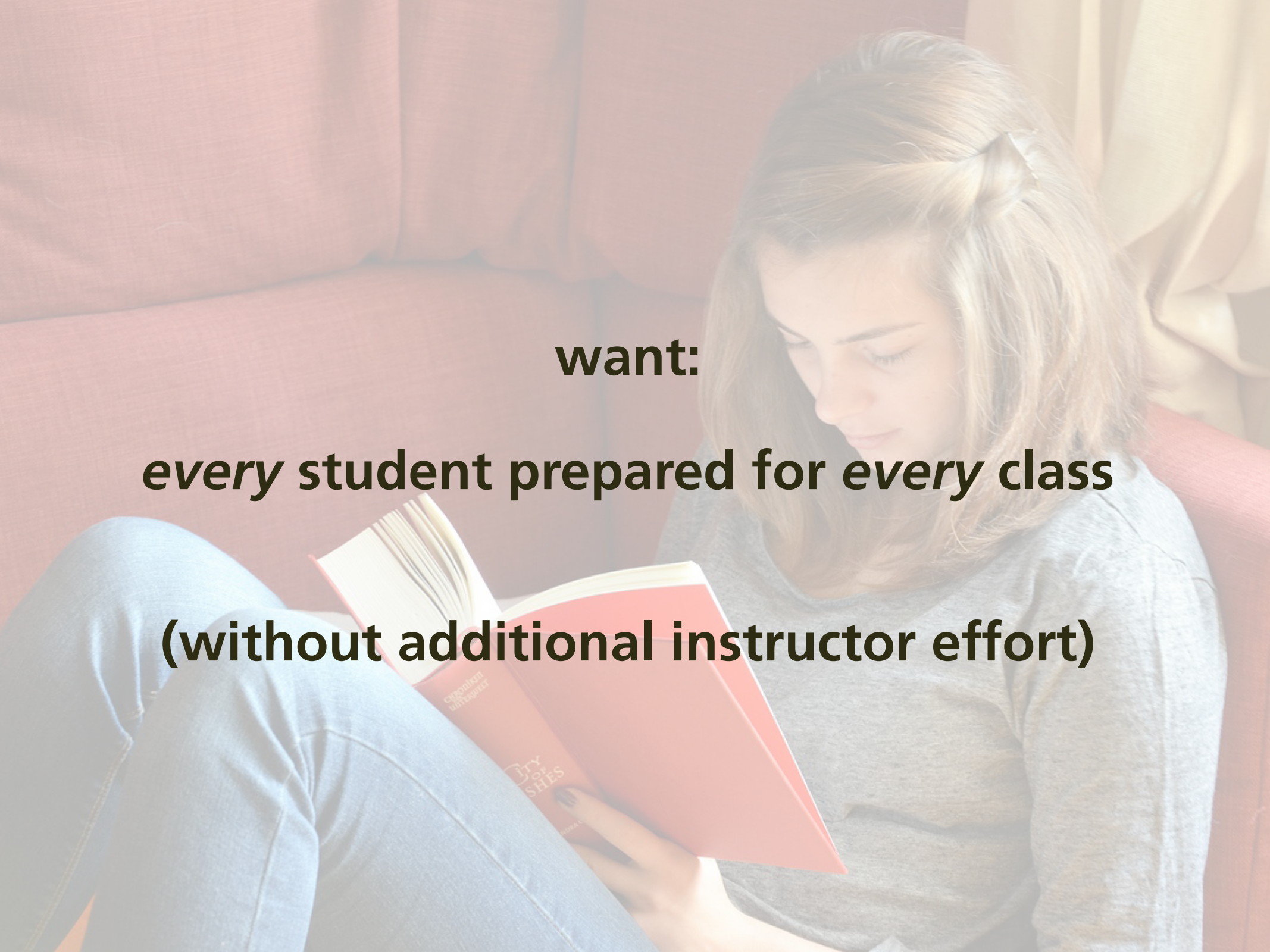
isolated/individual experience &

no real accountability



want:

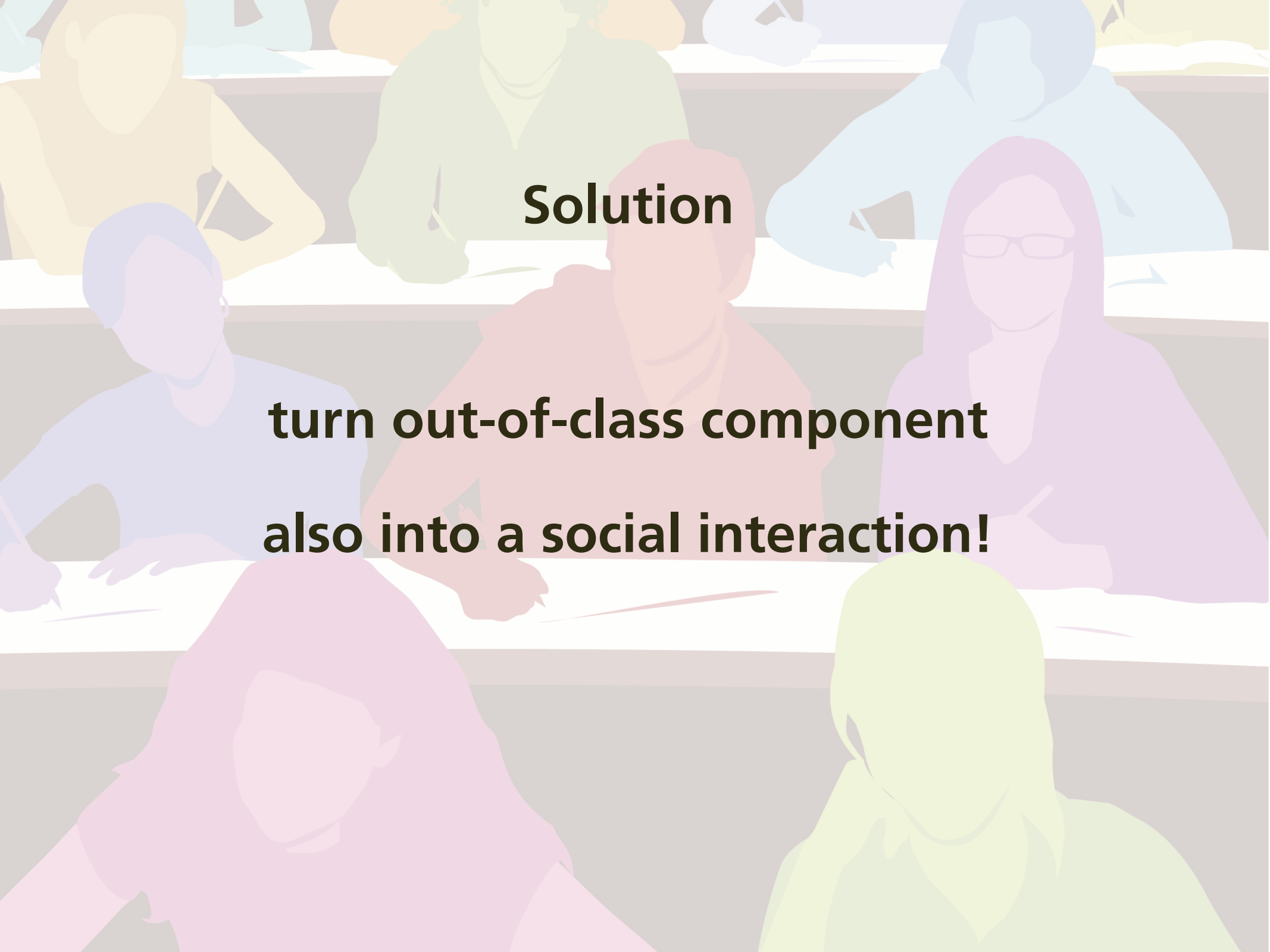
every student prepared for *every* class



want:

***every* student prepared for *every* class**

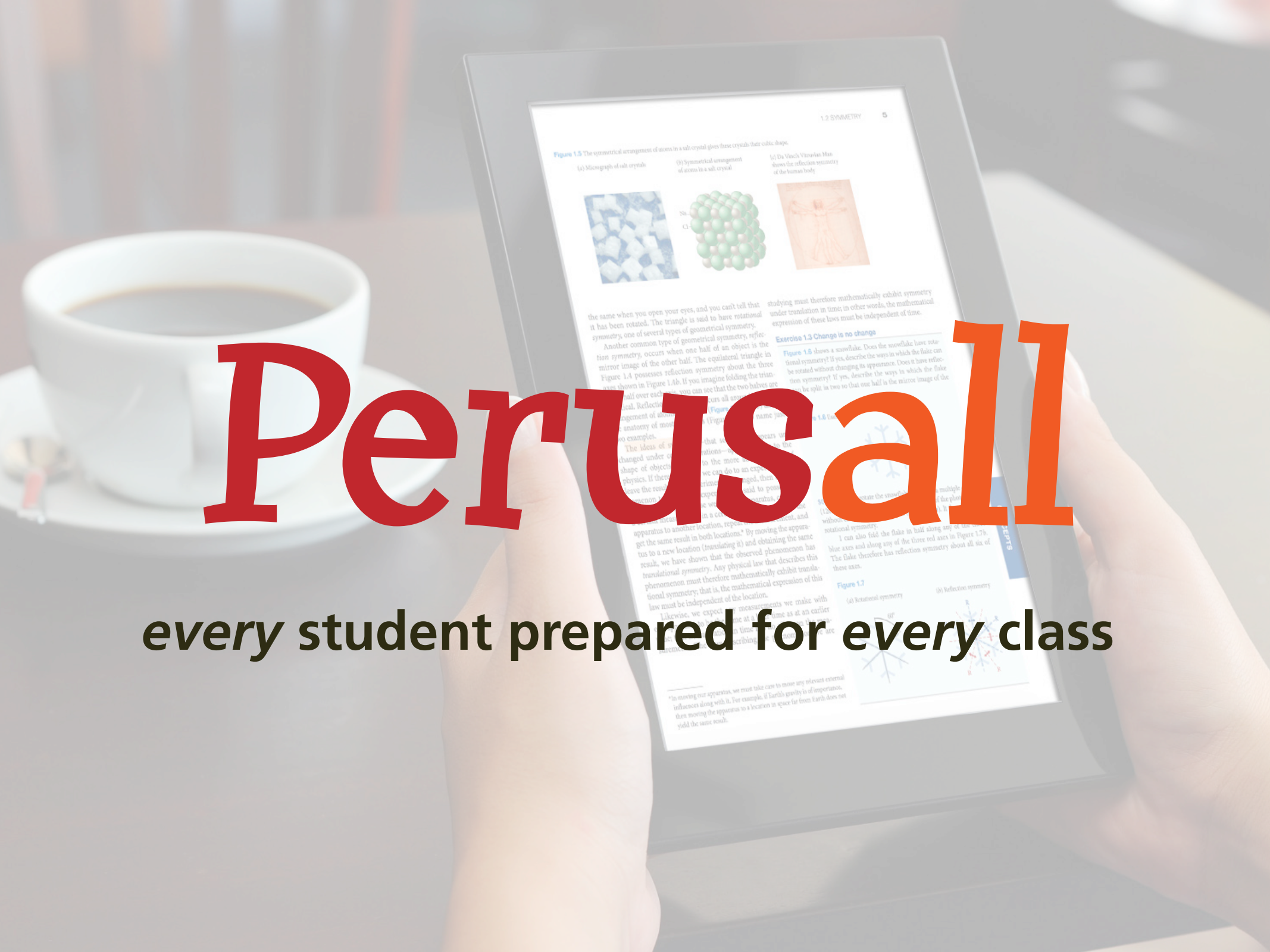
(without additional instructor effort)



Solution

turn out-of-class component

also into a social interaction!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every student prepared for every class

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All comments
Page 2
Eric Mazur

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.

4.1 Friction

Picture a block of wood sitting motionless on a smooth wooden surface. If you give the block a shove, it slides some distance but eventually comes to rest. Depending on the smoothness of the block and the smoothness of the wooden surface, this stopping may happen sooner or it may happen later. If the two surfaces in contact are very smooth and slippery, the block slides for a longer time interval than if the surfaces are rough. You [illegible] day experience: A hockey puck slides easily on ice but not on a rough road.

Figure 4.1 shows how the velocity of a wooden block decreases on three different surfaces. The slowing down is due to *friction*—the resistance to motion that one surface or object encounters when moving over another. Notice that, during the interval covered by the velocity-versus-time graph, the velocity decrease as the block slides over ice is hardly observable. The block slides easily over ice because there is very little friction between the two surfaces. The effect of friction is to bring two objects to rest with respect to each other—in this case the wooden block and the surface it is sliding on. The less friction there is, the longer it takes for the block to come to rest.

Figure 4.1 Velocity-versus-time graph for a wooden block sliding on three different surfaces. The rougher the surface, the more quickly the velocity decreases.

Figure 4.2 Low-friction track and carts used in the experiments described in this chapter.

You may wonder whether it is possible to make surfaces that have no friction at all, such that an object, once given a shove, continues to glide forever. There is no totally frictionless surface over which objects slide forever, but there are ways to minimize friction. You can, for instance, float an object on a cushion of air. This is most easily accomplished [illegible] the air serves as a cushion on which a conveniently shaped object can float, with friction between the object and the track all but eliminated. Alternatively, one can use wheeled carts with low-friction bearings on an ordinary track. Figure 4.2 shows low-friction carts you may have encountered in your lab or class. Although there is still some friction both for low-friction tracks and for the track shown in Figure 4.2, this friction is so small that it can be ignored during an experiment. For example, if the track in Figure 4.2 is horizontal, carts move along its length without slowing down appreciably. In other words:

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

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.

4.1 (*a*) Are the accelerations of the motions shown in Figure 4.1 constant? (*b*) For which surface is the acceleration largest in magnitude?

social learning platform

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CEPTS

log in through social network

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Figure 4.1 Velocity-versus-time graph for a wooden block sliding on three different surfaces. The rougher the surface, the more quickly the velocity decreases.

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

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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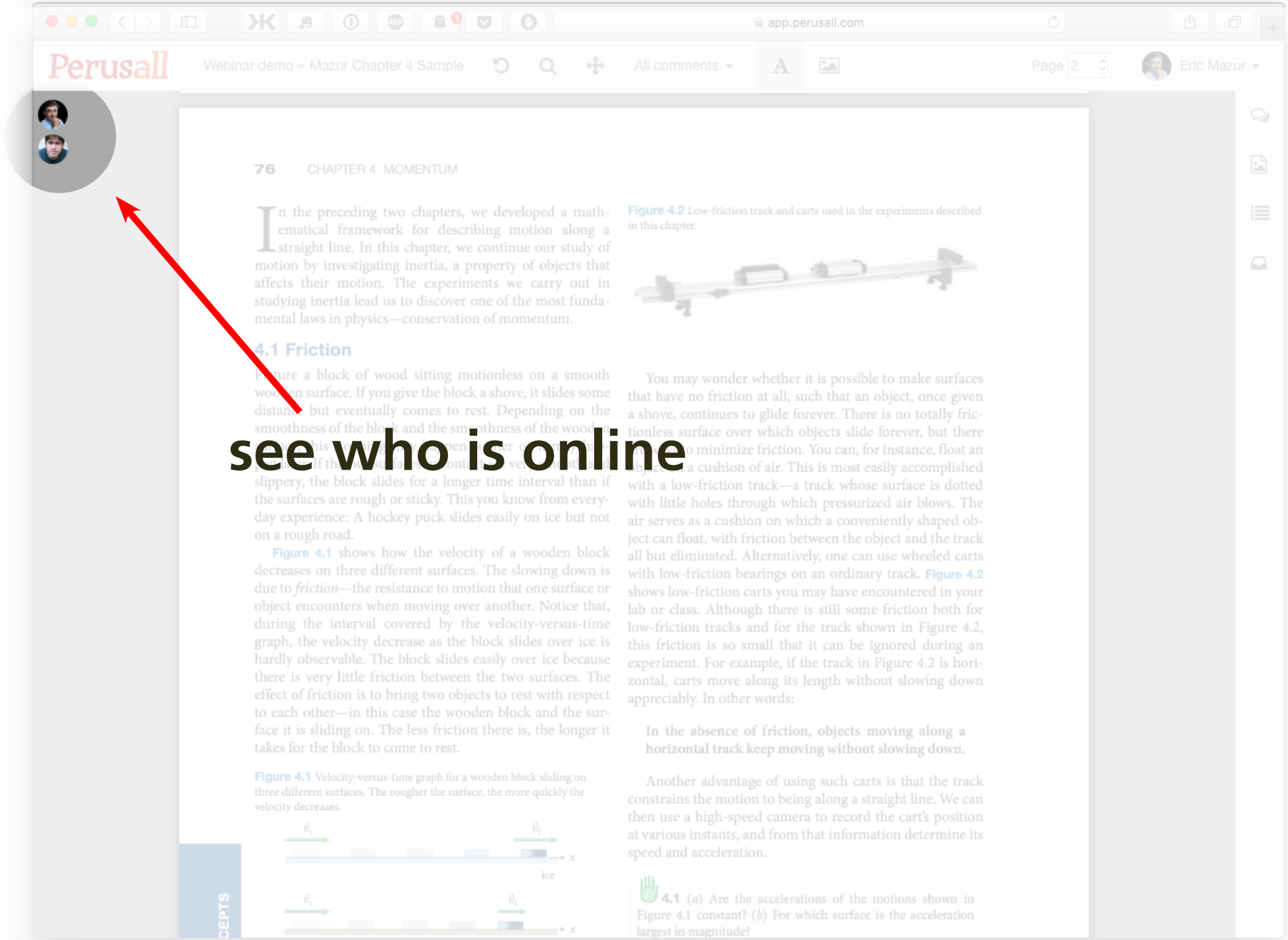
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All comments
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Eric Mazur
76 CHAPTER 4 MOMENTUM
In the preceding two chapters, we developed a mathematical framework for describing motion along a straight line. In this chapter, we continue our study 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.
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ice
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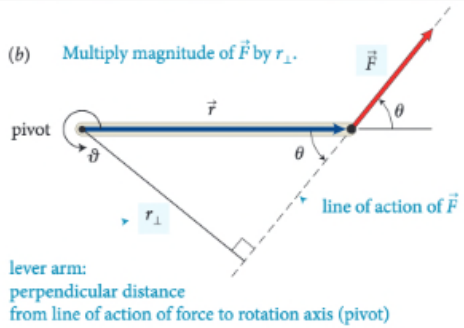


action of the force and the axis of rotation. So, the torque caused by a force exerted on an object is the product of the magnitude of the force and its lever arm distance. It can be written equivalently as $rF_\perp$ and as $r_\perp F$.

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 to rotate—for example, a plank or bridge supported at either end. To determine what reference point to use in such cases, complete the following exercise.

CONCEPTS

Exercise 12.1 Reference point

Consider again the rod in Figure 12.4. Calculate the sum of the torques about the left end of the rod.

SOLUTION I begin by making a sketch of the rod and the three forces exerted on it, showing their points of application on the rod (Figure 12.6).

reference point

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:

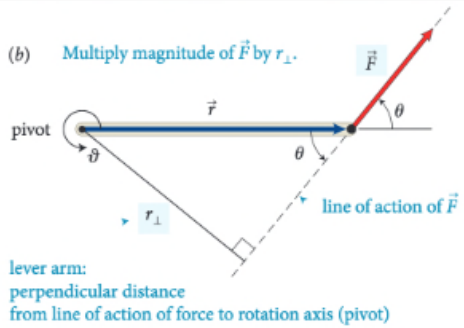
For a stationary object, the sum of the torques is zero.

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 12.2*a*, you must continue to exert a force on the seesaw to keep the child off the ground. The force you exert causes a torque on the seesaw, and yet the seesaw's rotational acceleration is zero. How can this be if torques cause objects to accelerate rotationally?

Example 12.2 Torques on lever

Three forces are exerted on the lever of Figure 12.7. Forces $\vec{F}_1$ and $\vec{F}_3$ are equal in magnitude, and the magnitude of $\vec{F}_2$ is half as great. Force $\vec{F}_1$ is horizontal, $\vec{F}_2$ and $\vec{F}_3$ are vertical, and the lever makes an angle of 45° with the horizontal. Do these forces cause the lever to rotate about the pivot? If so, in which direction?



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SB 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 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

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reference point

$\vec{F}_1$

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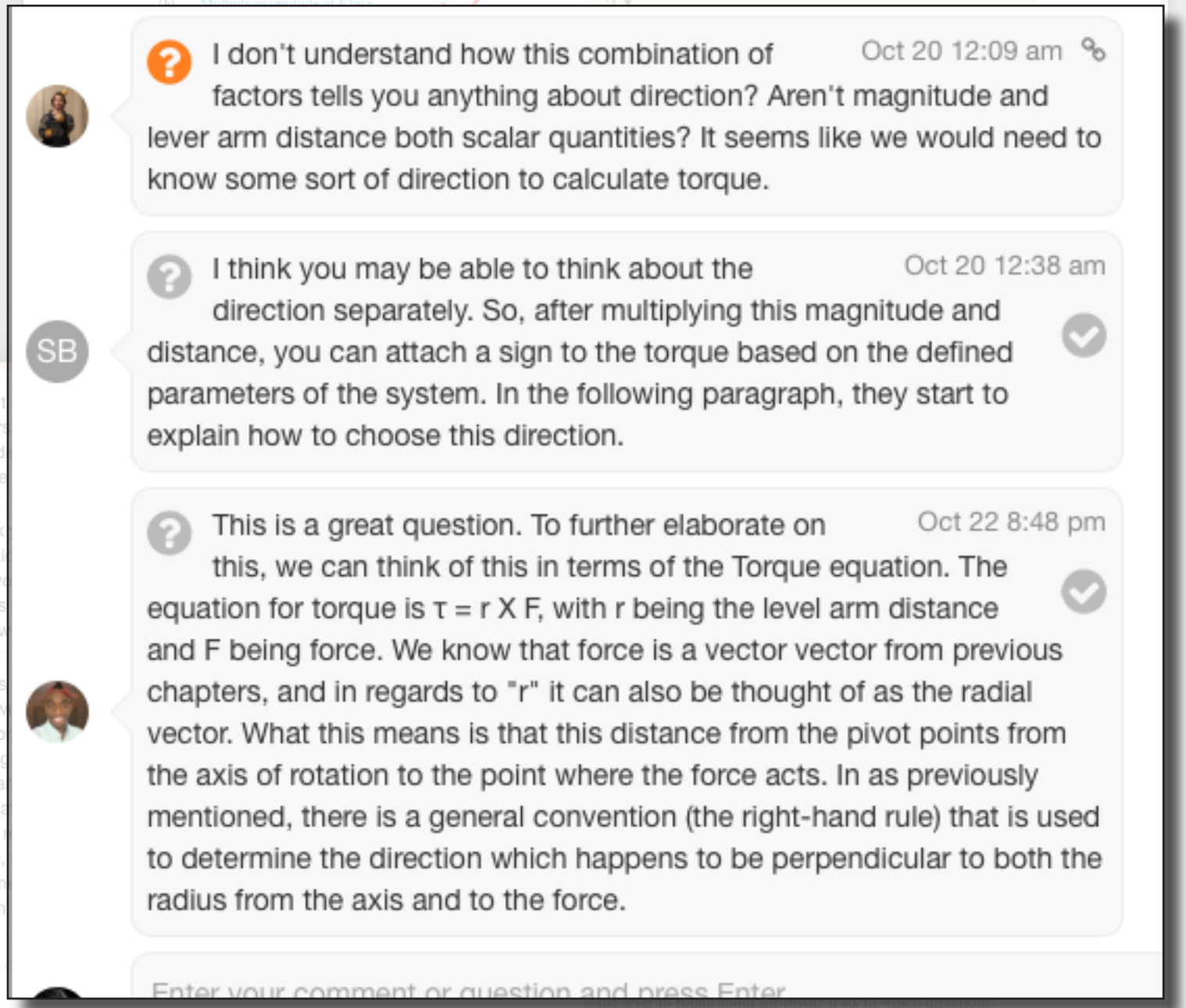
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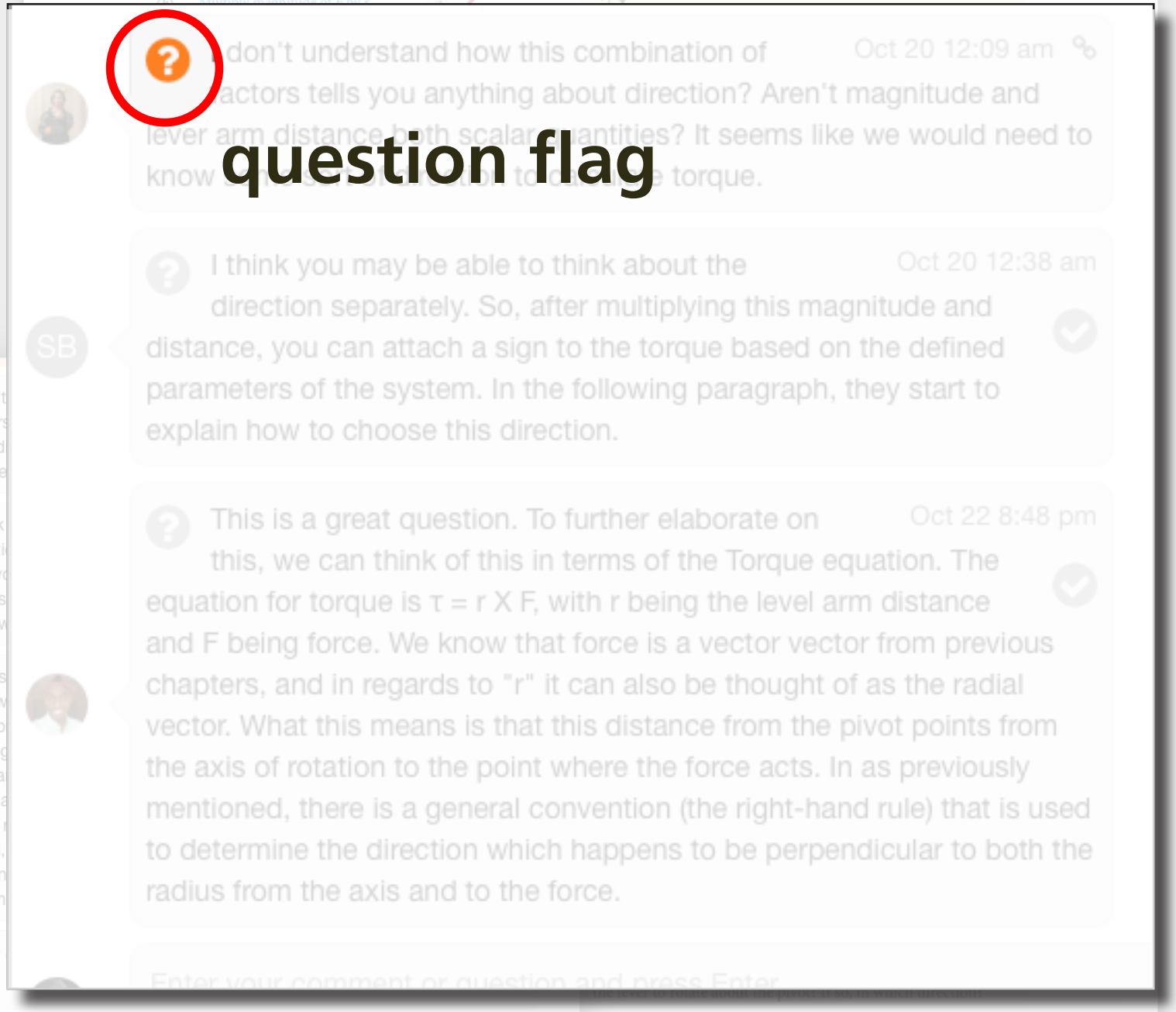
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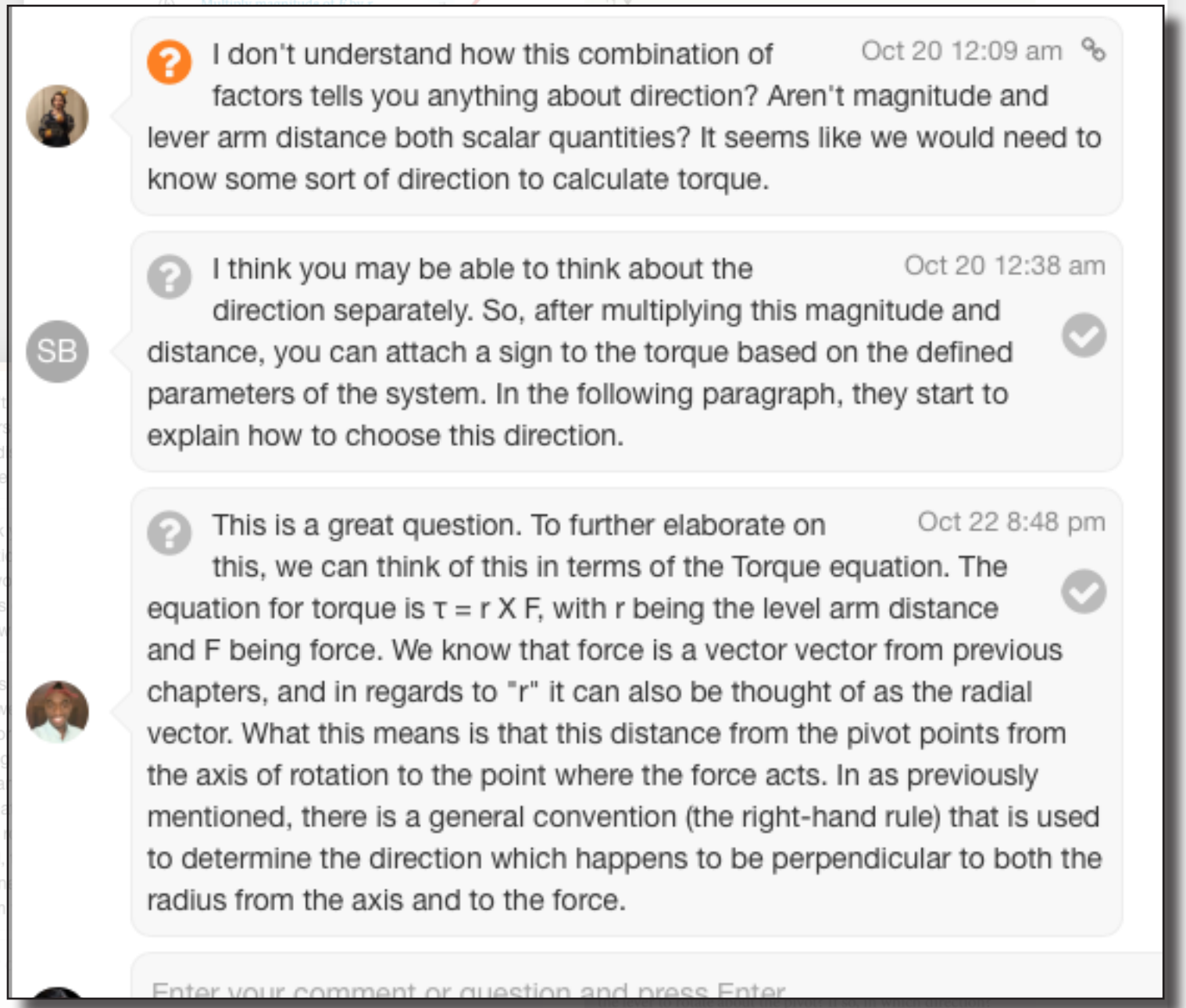
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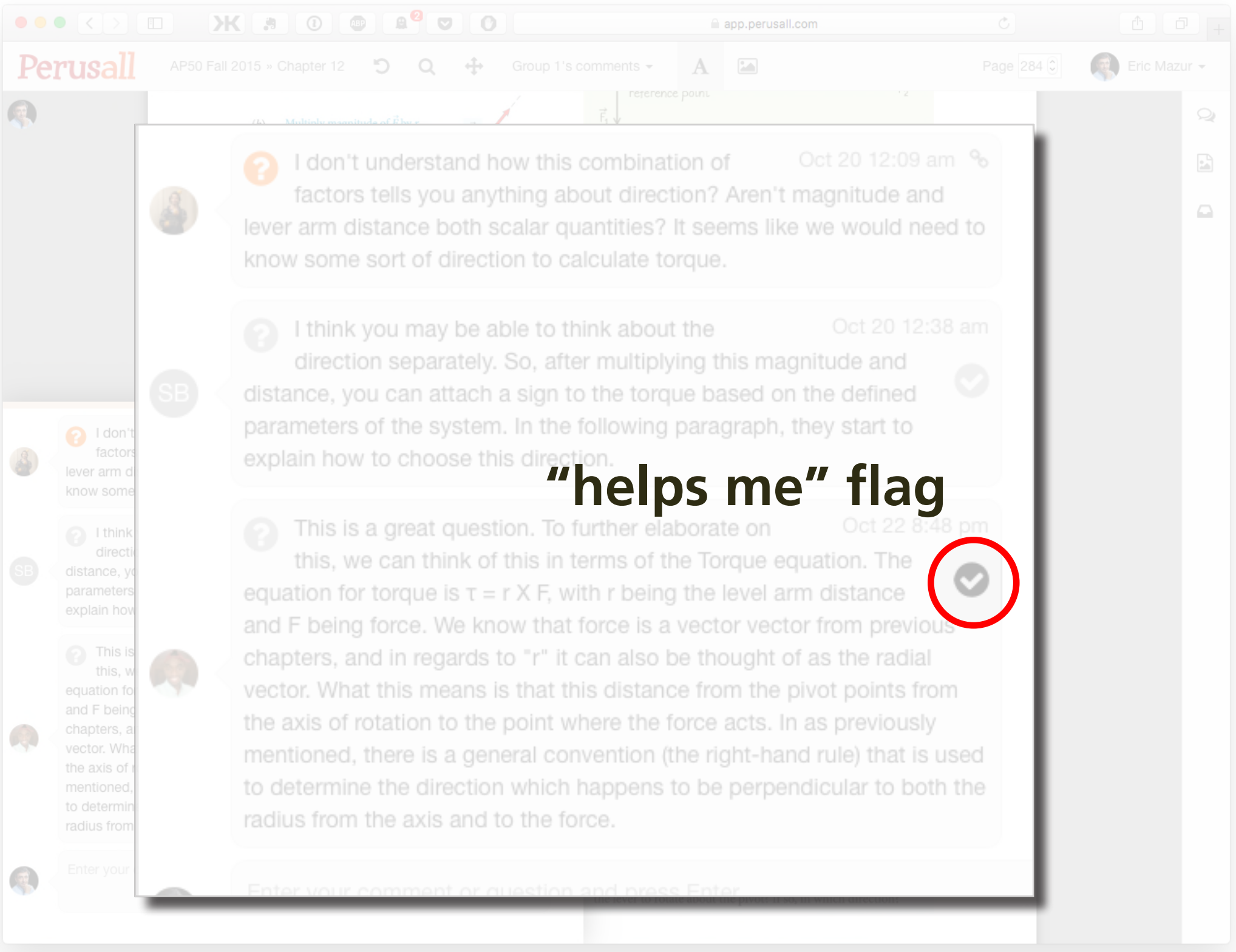
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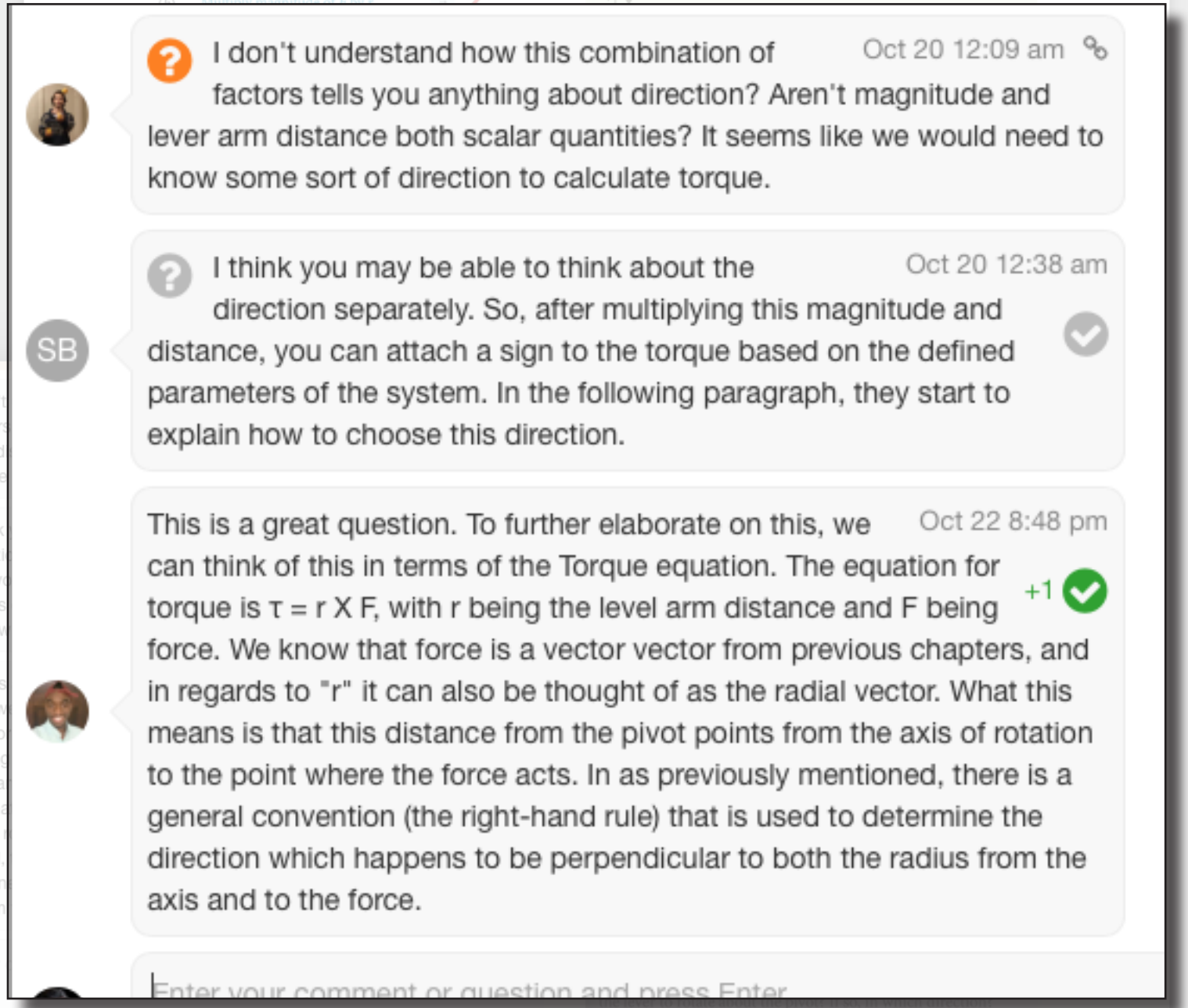
"helps me" flag


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
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Oct 22 8:48 pm
+1
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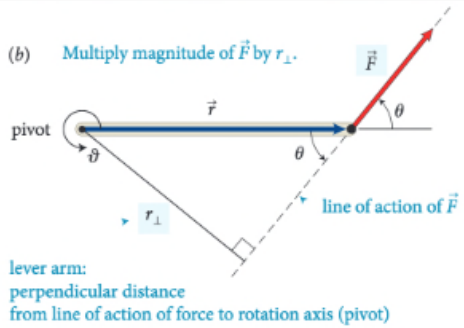

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reference point

$\vec{F}_1$

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Three forces are exerted on the lever of **Figure 12.7**. Forces $\vec{F}_1$ and $\vec{F}_3$ are equal in magnitude, and the magnitude of $\vec{F}_2$ is half as great. Force $\vec{F}_1$ is horizontal, $\vec{F}_2$ and $\vec{F}_3$ are vertical, and the lever makes an angle of 45° with the horizontal. Do these forces cause the lever to rotate about the pivot? If so, in which direction?

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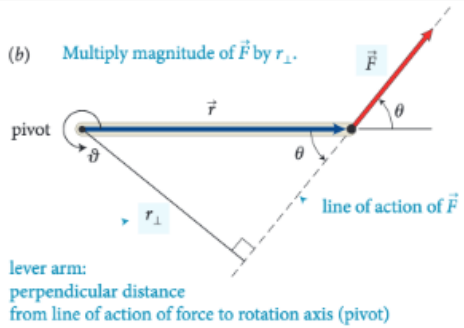

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- On the very left, we see th...
- It's interesting that the white ...
- Is the refernece frame i... 2
- How does force affect ... 2
- I was curious about this, t... 3
- I understand partially w... 3
- In this class, we always emp...
- The part before this wa... 2
- The extended free-body d... 4
- This just means the net... 3
- I don't understand why ... 3
- It is important to note that... 2
- This reminds me of when we ...
- Torque is the ability of a forc...
- The type of diagram to use d...
- It sounds like it is sayin... 3
- So then do we have a p... 5
- Since torque is the cross pro...
- The right-hand rule can al... 3
- I don't understand how ... 3
- Orientation-based descriptio...
- I don't really understan... 2
- How small is small? As ... 3
- I think it would be slightly ...
- While I believe I underst... 3
- (a) The change in rotationa...
- As we saw earlier in the chap...
- Objects executing motion ar...
- Generally, for rotating bod... 2
- Does torque have the s... 3

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Brian Lukoff responded to a question in Mazur Chapter 4 Sample that you wanted to know the answer to

21 minutes ago, you asked this question on Perusall:

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

Brian Lukoff just responded to the question by saying:

> Right - I think there will always be some friction due to the second law of thermodynamics.

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option 3: mark as answered

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how to get students to participate?

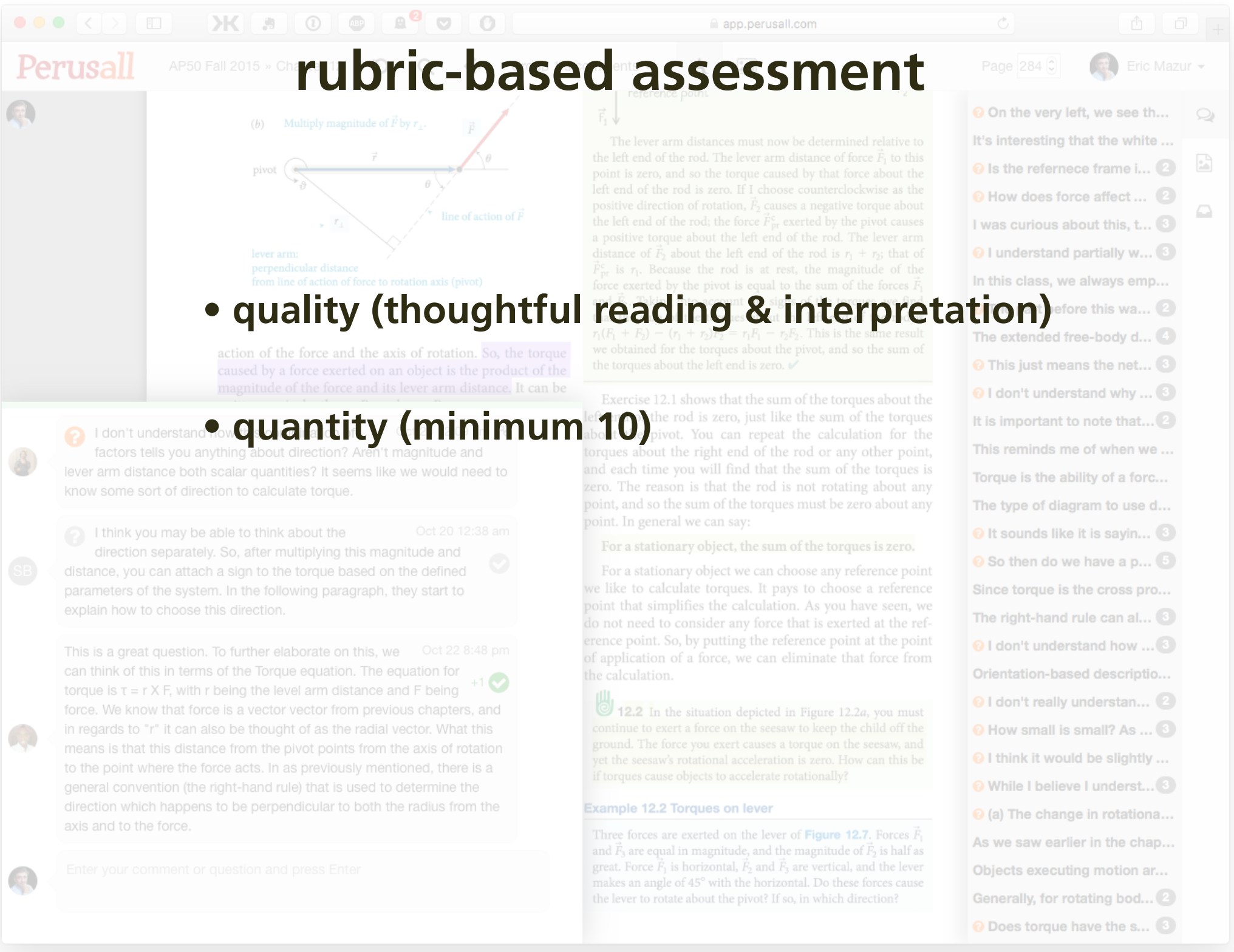
use combination of intrinsic and extrinsic motivation drivers

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

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.

4.1 Friction

Picture a block of wood sitting motionless on a smooth wooden surface. If you give the block a shove, it slides some distance but eventually comes to rest. Depending on the smoothness of the block and the smoothness of the wooden surface, this stopping may happen sooner or it may happen later. If the two surfaces in contact are very smooth and slippery, the block slides for a longer time interval than if the surfaces are rough or sticky. This you know from everyday experience: A hockey puck slides easily on ice but not on a rough road.

Figure 4.1 shows how the velocity of a wooden block decreases on three different surfaces. The slowing down is due to *friction*—the resistance to motion that one surface or object encounters when moving over another. Notice that, during the interval covered by the velocity-versus-time graph, the velocity decrease as the block slides over ice is hardly observable. The block slides easily over ice because there is very little friction between the two surfaces. The effect of friction is to bring two objects to rest with respect to each other—in this case the wooden block and the surface it is sliding on. The less friction there is, the longer it takes for the block to come to rest.

Figure 4.1 Velocity-versus-time graph for a wooden block sliding on three different surfaces. The rougher the surface, the more quickly the velocity decreases.

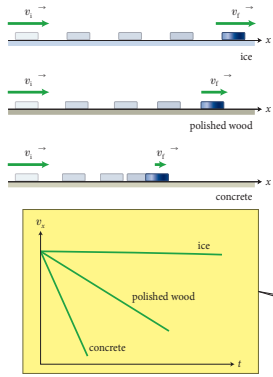


Figure 4.2 Low-friction track and carts used in the experiments described in this chapter.

You may wonder whether it is possible to make surfaces that have no friction at all, such that an object, once given a shove, continues to glide forever. There is no totally frictionless surface over which objects slide forever, but there are ways to minimize friction. You can, for instance, float an object on a cushion of air. This is most easily accomplished with a low-friction track—a track whose surface is dotted with little holes through which pressurized air blows. The air serves as a cushion on which a conveniently shaped object can float, with friction between the object and the track all but eliminated. Alternatively, one can use wheeled carts with low-friction bearings on an ordinary track. Figure 4.2 shows low-friction carts you may have encountered in your lab or class. Although there is still some friction both for low-friction tracks and for the track shown in Figure 4.2, this friction is so small that it can be ignored during an experiment. For example, if the track in Figure 4.2 is horizontal, carts move along its length without slowing down appreciably. In other words:

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

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.

4.1 (*a*) Are the accelerations of the motions shown in Figure 4.1 constant? (*b*) For which surface is the acceleration largest in magnitude?

4.2 Inertia

We can discover one of the most fundamental principles of physics by studying how the velocities of two low-friction carts change when the carts collide. Let's first see what happens with two identical carts. We call these *standard carts* because we'll use them as a standard against which to compare the motion of other carts. First we put one standard cart on the low-friction track and make sure it doesn't move. Next we place the second cart on the track some distance from the first one and give the second cart a shove toward the first. The two carts collide, and the collision alters the velocities of both.

CONCEPTS

ANNOTATION	EVALUATION	
Alan: I remember, in high school, being amazed at how quickly carts could travel on these tracks - air would blow up through these tiny holes evenly distributed along the length of the track and the cart would essentially float on the air and consequently - the cart would move very quickly with the slightest push.	No substance. Does not demonstrate any thoughtful interpretation of the text.	0
Bob: Although there is no way to create frictionless surfaces, I find it interesting that we consider experiments "in the absence of friction." In a way, this relates back to Chapter 1.5 where we talked about the importance of having too little or too much information in our representations. In some cases, the friction is so insignificant that we ignore it (simplifying our representation).	Annotation interprets the text and demonstrates understanding of concepts through analogy and synthesis of multiple concepts.	2
Claire: Does this only apply to solid surfaces? I feel as if a substance that floats on water either has negligible or very little friction.	Possibly insightful question but does not elaborate on thought process, nor demonstrate thoughtful reading of the text.	1
Alan: Why is this? I don't get it. **David**: believe this applies to almost every surface, although I'm not sure if water would count more as resistance than friction. Anyways, the best example I could think of would be a surf board. If people who were paddling in the same direction as the waves experienced no resistance, they would continually speed up, and eventually reach very high speeds. However, in reality if they were two stop paddling they'd slow down and only the waves would slowly push them to shore.	Question does not explicitly identify point of confusion nor demonstrates thoughtful reading or interpretation of the text. Response demonstrates a thoughtful explanation with a claim substantiated with a concrete example	0 2
Alan: Is it possible to have a surface, in real life, that inflicts NO friction at all?	Question exhibits superficial reading, but does not exhibit any interpretation of the textbook.	1
Erica: Doesn't air resistance factor into this at all? It seems that it is not enough for there to be only an absense of friction for something to keep moving without slowing down. What about some other opposing force - like air resistance? Or is air resistance just another example of friction? **Bob**: The key word is "appreciably". In the absense of friction, the cart does not slow down appreciably but still would a little due to air resistance	Demonstrates thoughtful interpretation of the text by refuting a statement through a counter example. Responds to the question by thoughtfully interpreting the text	2 2
Alan: a) yes b) concrete has the acceleration of greatest magnitude	Annotation not backed up by any reasoning or theoretical assumptions. No evidence of thoughtful reading of text.	0
Erica: I would think that they are not constant because if we think of the formula F=ma, the force of friction is different in every case so that would change the acceleration value (where mass would stay the same since it's assumed that th object is the same in each situation).	Response backed up with reasoning that demonstrates an interpretation of the text and applies understanding of concepts	2
Claire: As a theoretical question about inertia, if an object in motion will stay in motion, but is being affected by friction, will it slow down perpetually but remain in motion, or will it eventually stop completely due to the friction? Just curious. **Alan**: With friction everything slows down to a half at one point or another. It is only if an outside force acts on the object if that object will maintain motion after the effects of inertia.	Profound question that goes beyond the material covered in the textbook. Demonstrates some thought but does not really address Claire's question	2 1
Claire: Standard carts: identical carts in mass, shape, etc. I like this notion of standard carts, it provides a good baseline to compare other motion and to understand the concepts before building on it.	No substance. Does not demonstrate any thoughtful reading.	0
Alan: Great visual representation of friction! It is interesting how this compares the velocity of things on different surfaces	No substance. Does not demonstrate any thoughtful reading.	0
Bob: The rougher the surface, the more friction between the surface and the wooden block, and thus acceleration will be greater.	Interprets the graph and applies understanding of both the concept of friction, how a v-t graph correponds to acceleration and the relationship between the force of friction and acceleration	2

rubric-based assessment

ANNOTATION	EVALUATION
Alan: I remember, in high school, being amazed at how quickly carts could travel on these tracks - air would blow up through these tiny holes evenly distributed along the length of the track and the cart would essentially float on the air and consequently - the cart would move very quickly with the slightest push.	No substance. Does not demonstrate any thoughtful interpretation of the text. **0**
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Alan: Why is this? I don't get it.	Question does not explicitly identify point of confusion nor demonstrates thoughtful reading or interpretation of the text. **0**
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rubric-based assessment

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

over 20,000 annotations!

rubric-based assessment

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- quantity (minimum 10)
- timeliness (before class)
- distribution (not clustered)

how do you process all of that??

rubric-based assessment

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- timeliness (before class)
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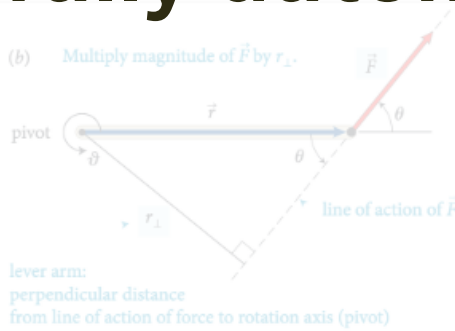
how do you process all of that??

fully automated assessment

fully automated assessment

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



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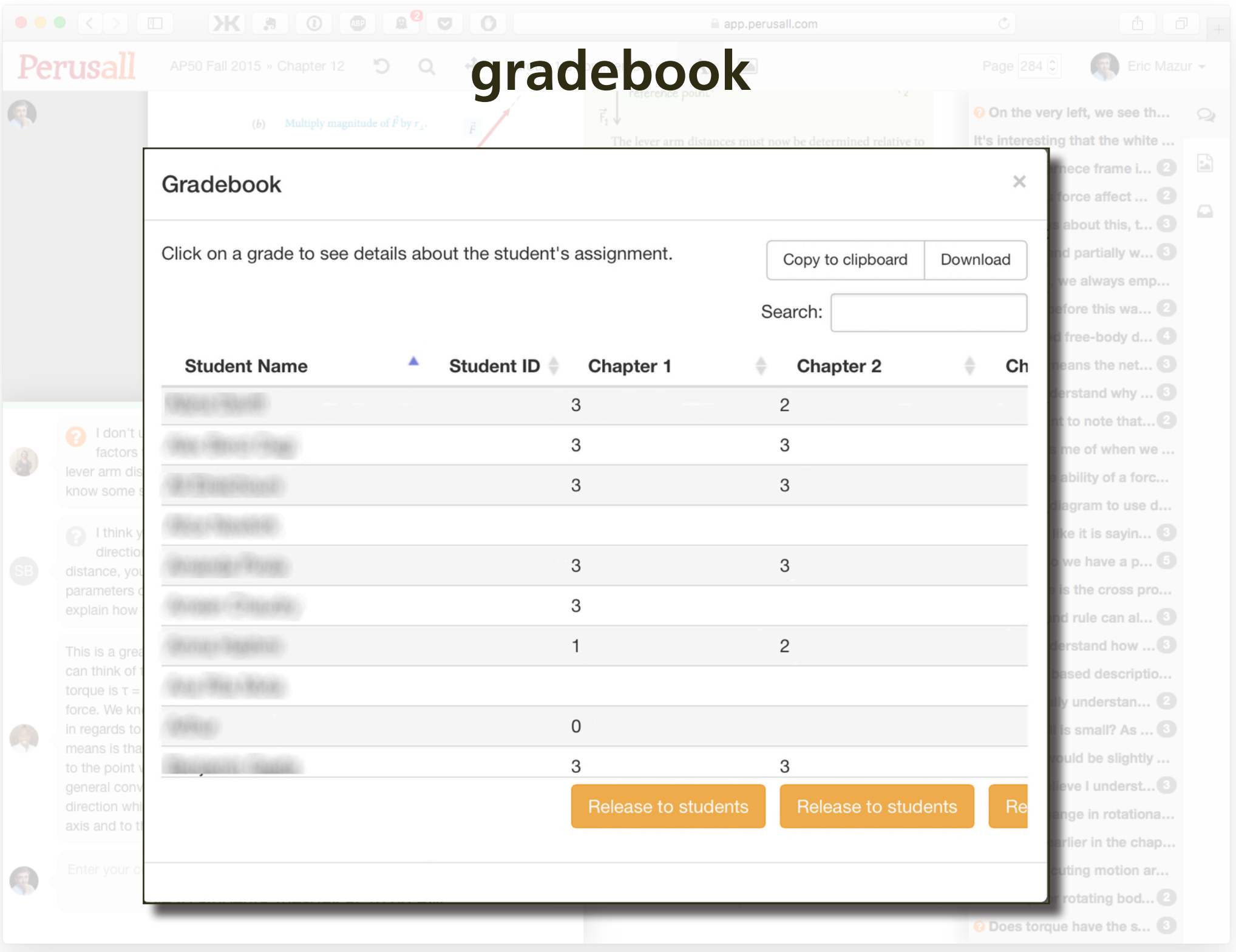
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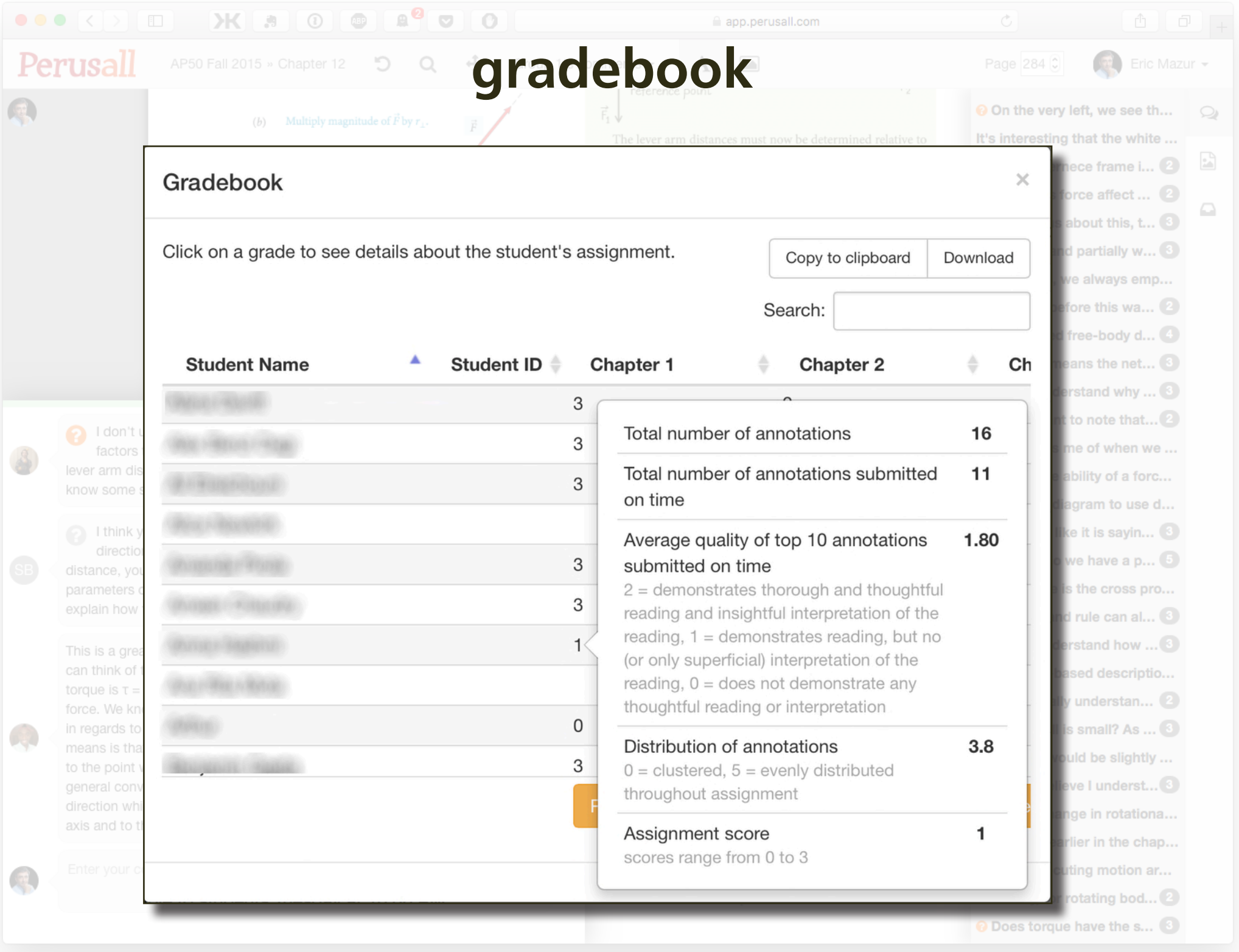
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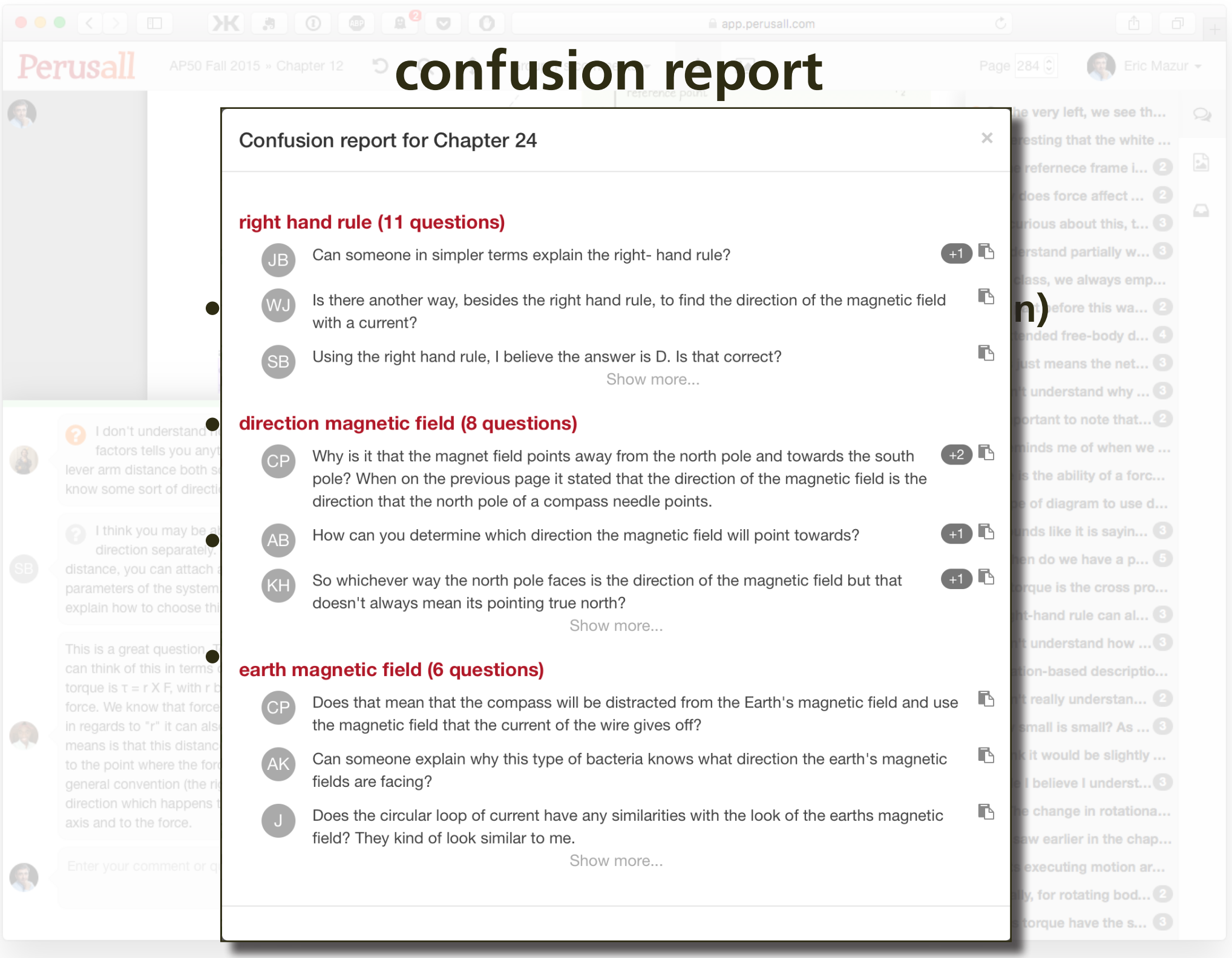
Gradebook
Click on a grade to see details about the student's assignment.
Copy to clipboard
Download
Search:
Student Name
Student ID
Chapter 1
Chapter 2
Ch
Total number of annotations 16
Total number of annotations submitted on time 11
Average quality of top 10 annotations submitted on time 1.80
2 = demonstrates thorough and thoughtful reading and insightful interpretation of the reading, 1 = demonstrates reading, but no (or only superficial) interpretation of the reading, 0 = does not demonstrate any thoughtful reading or interpretation
Distribution of annotations 3.8
0 = clustered, 5 = evenly distributed throughout assignment
Assignment score 1
scores range from 0 to 3

connect pre-class and in-class activities

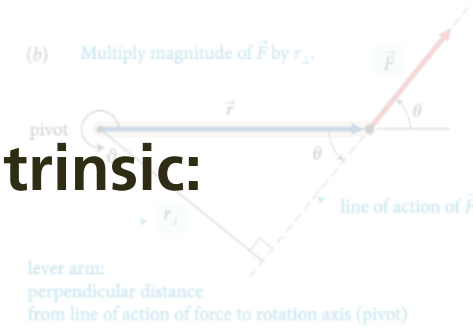
confusion report



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)

motivating factors

"I think the Perusall app and annotation system is way better than just reading a text-book normally… I've been reading for almost four hours now and haven't gotten bored"

Harvard student

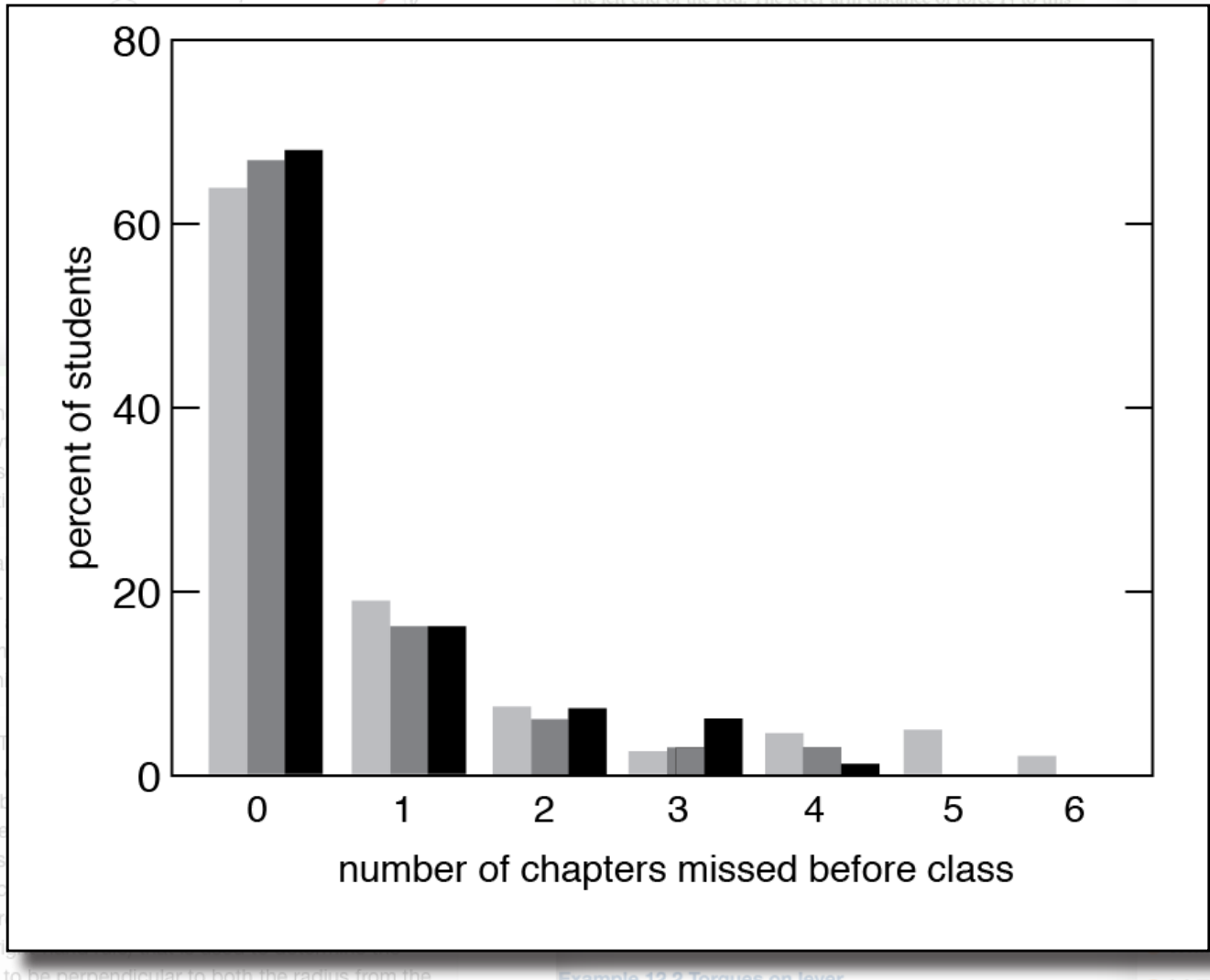
motivating factors

"It makes the book fun to read…

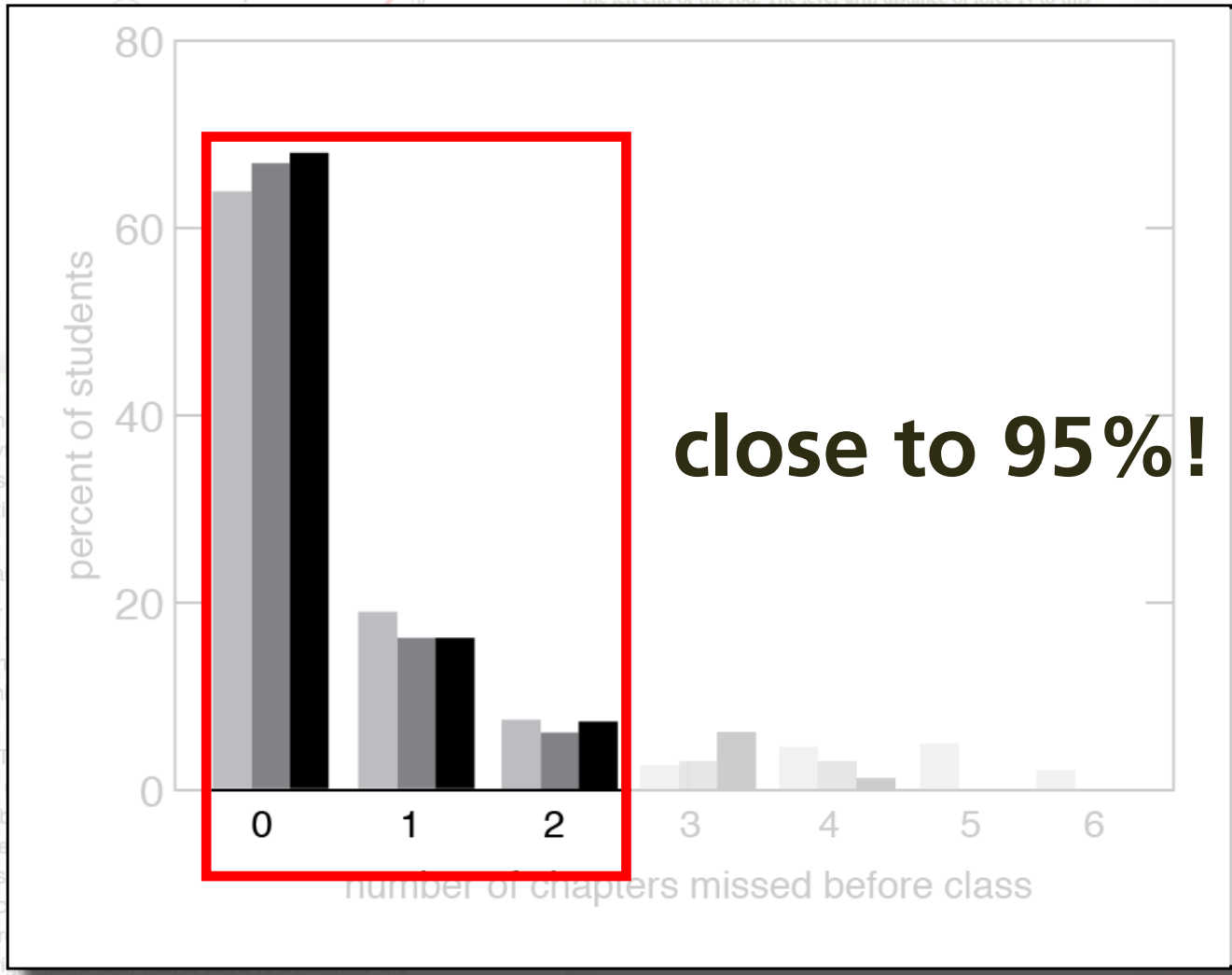
All the other students on my floor are disappointed their Prof isn't using Perusall because they don't read the book."

Ohio State student

class test results



class test results



close to 95%!

class test results

every student prepared for *every* class

Benefits

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

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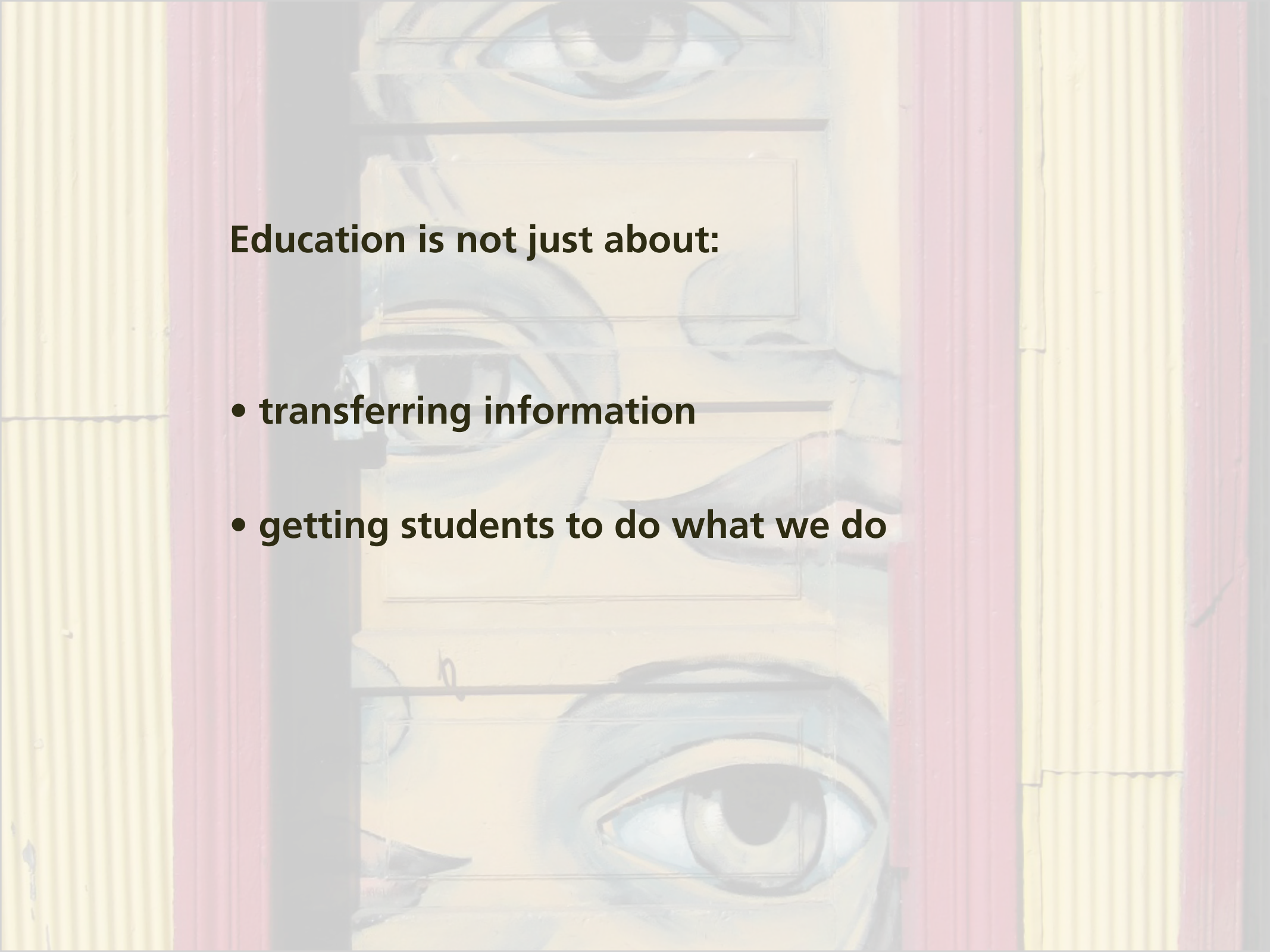
all at no cost & without additional instructor effort!



Education is not just about:

- transferring information
- getting students to do what we do

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active engagement/social interaction a must!

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