



Unit on Force and Motion: March 7th

Sudden Stops Hurt: Investigating Forces and Motion during a “Car” Collision



To understand the language in these commentaries...

It is important to have read our Discourse Primer, found at:

http://tools4teachingscience.org/tools/discourse_tools/primer.html

The commentaries also draw upon the language of our Discourse Tools, which should also be reviewed first:

http://tools4teachingscience.org/tools/discourse_tools/index.html



As you watch this video episode...

Keep track of where you are by noting the time codes in the left-hand column. In the right-hand column are important features of the classroom discourse.

In one or more of the time segments, we ask you to do more than follow along—we leave the discourse commentary section blank. Here we ask you to listen closely to the video and fill in the commentary yourself.

The teacher’s commentary for these sections can be found at the end of the document. Compare what you heard with what the teacher noted.

Summary of Episodes:

1. Instead of doing a simple “ramp” lab activity, I decided to expand a typical carts-on-ramps activity and have students think about and investigate a more complex scenario. The kids are investigating the fate of two different “passengers” – one large and one small – who are riding, without a seatbelt, in a car traveling down a hill and colliding with a brick wall. They are observing the motion of the cart, of course, but what they are really trying to explain is the motion of the passenger AFTER the collision when the cart has stopped moving and the un-seatbelted passengers are ejected from the cart. While there is probably a “correct” model for the movement of the passengers, I am more interested in hearing how students reason with the following ideas: 1) the passengers have different mass – does it matter for their motion?, 2) the passengers are “at rest” with respect to the cart – does this kind of inertia matter for this event?, 3) the passengers are “in motion” with respect to the ramp/brick wall – does this kind of inertia matter for this event?, 4) many forces are interacting in this scenario – do the forces matter for this event?

Time points	Commentary
0:00 → 2:49	Important ideas/language I heard:
Initially, I wasn’t going to have students read their narratives out loud, but they were SO EXCITED about them that they demanded time to share. So, of course, I let them share.	Clayton’s story: Clayton’s narrative is a little different from Liliana’s narrative. Clayton writes a story-telling section that is very animated, and then he switches “registers” into a physics description section that sounds more typical of how students think science texts are supposed to sound. I think Clayton has made sense of some science ideas, but he is still working on becoming “fluent” in the science register.
	Liliana’s story: Liliana’s narrative weaves story-telling elements together with some (tentative) explanatory elements about the forces and motion of the cars in the collision. She uses some of her Newtonian straight-line motion ideas to think about more complex motion that she imagines in the car collision – a

blue Mustang spinning after being hit by a big Hummer. Liliana is making sense of science ideas and I think she is becoming very fluent in the science register.

Literacy support:

You can hear both Clayton and Liliana working hard to appropriate the physics talk as part of their narrative. You can also hear how the narrative or story-telling structure helped get both students motivated to write and talk about physics ideas in a way that a science “report” does not.

2:50 → 9:38

During this segment I am giving instructions & demonstrating how to set up the tests of the cars rolling down a hill & crashing with unsecured passengers inside.

Why Am I Doing This?

I’m doing this not only because the procedure and the set-up are a little tricky, but also because I want kids to see a couple of trial runs of the set-up before they talk and write about their hypotheses and mental models for this investigation. When kids have to make a hypothesis without seeing a few trials, I find that they tend to give me overly simple predictions without any reasoning or elaboration. If I get their ideas “primed” by having them watch a few trials, then I seem to have more success getting students to craft more elaborate hypotheses and models for expected outcomes of an investigation.

Good to Know:

Although this unit of instruction is ambitious overall, there are elements of “traditional” physics instruction that you can see in this lesson. I assign a traditional physics problem set in addition to the narrative and explanatory writing that the students are working on. I also talk with students about good principles of experimental design. I try to fold these traditional elements into the more progressive elements of instruction and remain focused on my priorities with students – constructing well-articulated evidence-based explanations that combine students’ ideas, science ideas, and evidence gathered from observations.

9:39 → 12:21

Hilina & Hanad discuss their hypotheses and mental models about how they expect the Play-Doh passenger to move during the crash & why.

Important ideas/language I heard:

Hilina:

- Reasoning about the direction of the movement of the passenger – based on both the forces and the direction of velocity. She also invokes the 2nd Law.
- Reasoning about the relationships between mass, force, and acceleration using the 2nd Law – thinking about how the large passenger will move differently from the small passenger.

Hanad:

- Tries to paraphrase what Hilina said but he is struggling with the direction of movement. He suggests that the passengers may move backwards inside of the car before they move forward or are ejected from the car.

12:22 → 14:25

Round of small

Good to Know:

In Discourse 2 we suggest that sometimes you need to do one “round” of visits to each group to double check (briefly) on some procedural issues and

group talk that is predominantly procedural to get everyone moving in the right direction on the activity.

make sure that each group is managing the material activity. This is a good example of what that looks & sounds like.

14:26 → 19:43

REALLY GOOD EXAMPLE of what “PRESS” looks like & sounds like – especially after 16:14

Visiting Yael, Liliana, Shawna, Amy in order to have a round of talk focused on IDEAS instead of procedures.

Important ideas/language I heard:

14:40 – Yael + Shawna make their initial claim about how the passengers will move when they are ejected from the car during the collision – “Since there’s more mass, the big guy won’t go as far.” -- This initial claim is the starting point for this WHOLE episode of talk AND we return to this claim during the last episode which begins at 25:41.

15:18 – Shawna adds to Yael’s claim that “it’s because it has more mass” by saying that it will “take more speed or more forces to get it moving” ... and I help her attach the term “inertia” to this idea – she has fully expressed the concept, but she hasn’t quite attached the physics word to her idea.

15:44 – Liliana starts to contribute a counter-claim, but then decides that Yael and Shawna’s claim sounds pretty convincing so she decides that maybe she agrees with them and she adds the idea that the “big one will have a hard time rolling” because of its mass.

AFTER my question at 16:14 ...

The students are visibly working at the edge of their current understanding. SUPER interesting to try to follow their thinking during this section.

17:15 – Yael – “Doesn’t it also have something to do with opposite forces and equal forces?” ... He’s starting to go beyond his earlier claim (which sounded law-like – “it has more mass so it will travel less”) and he’s starting to add some complexity about the forces that will be interacting with the cart and with the passenger.

18:12 – Liliana – “It would have to be more steeper ...” Liliana suggests a potential experiment as a thought experiment creating a scenario where she thinks she could make the two different sized passengers behave the same way by increasing the ramp (which she thinks will add more “speed” or “force” to the bigger passenger). Yael builds on this idea by suggesting that there is a “ratio” to think about – the slope of the ramp AND the distance that the cart travels along the ramp.

AFTER their first trial with the “big” passenger, they observe that the big ball of Play-Doh rolls really far after the crash.

19:40 – Liliana: “Hey! My idea was right the first time!” – she now wants to return to her previous counter-claim (which she never really said out loud because Yael’s claim was more persuasive) after seeing how the passenger moved.

Questions I use to help kids say more (you fill in below, then check your observations against teacher commentary at end of this document)

Other important discourse moves:

Press for Explanation:

Students have thus far based their hypothesis on the idea that the larger Play-Doh has more mass, and therefore more weight, making it more likely to stay “at rest” in the car and less likely to eject very far from the car. I’m not sure if they are considering the fact that the Play-Doh AND the car are both going to be “in motion” when they collide with the brick, so I want the students to consider the idea that the passengers of a car are “in motion” even when they are sitting in a moving car.

16:14 – “Well, what about the inertia of being ‘in motion’ – doesn’t more mass mean that it will have more inertia when it’s in motion?”

*Listening to their responses after this question is SUPER interesting because you can almost see the wheels turning inside of their heads as they push against the limits of their current thinking.

19:44 → 21:19

Visiting Jadyn, Bradley, Clayton and talking about the “fat guy” and how he will stay in motion because “he’s so fat.”

Important ideas/language I heard:

20:00 – This group of boys is making the claim that the big passenger travels farther than the small passenger after the collision with the brick “because it has more mass.”

20:30 – Clayton mentions that “more mass” means that there is “more gravity” – I think he means weight in this case. Jadyn mentions that “more mass” means that there is “more inertia.” Taken together these two ideas are starting to form an increasingly complex model explaining the motion that they observed.

Questions I use to help kids say more:

19:50 – “How does your data from the “fat guy” (their term for the big ball of Play-Doh) compare with the “skinny guy?”” – This is one of the types of questions that we suggest in Discourse Tool 2 prompting students to begin making comparisons between conditions to help them start talking about patterns in their data.

21:20 → 25:40

Giving instructions about how to complete the writing and drawing portion of the “Sudden Stops Hurt” assignment.

Also, talking about some extension questions about passengers riding on the Metro bus.

25:41 → end

Important ideas/language I heard:

More work with Yael, Liliana, and Shawna about their ideas about inertia and forces.

26:16 – Liliana explains how her hypotheses have changed over time ... “At first I thought ...” and she then uses the data to choose between the two claims. BUT, like many students, she stops short of providing an explanation -- she stops at justifying her assertion with data points but does not provide a scientific explanation theorizing about the underlying causes. So, I press her to add an explanation.

27:31 – Liliana works to add an explanation that invokes physics principles and unobservables (e.g., “mass”, “speed”, and “pushes” or “rolls”) – It’s a challenge to listen generously to her explanation because she is using observable kinds of everyday words to try to express difficult concepts. I think when she is talking about “mass” she might actually be talking about inertia, and her ideas about speed and rolling might actually be ideas about forces.

28:45 – Yael explains part of his thinking about the Play-Doh passengers – “I wasn’t really thinking about the flying part ... I was just thinking about the ‘down’ part” (considering that I have NOT worked with kids to break vectors into their components, this is VERY sophisticated thinking for Yael – he is already thinking about how complex forces can be broken down into components!)

30:00 – Yael points out that there are actually two pieces of post-collision motion that we should be paying attention to: 1) the passenger flying through the air, 2) the passenger rolling on the ground. He is parsing the motion into pieces and then working on explaining the pieces – which is EXACTLY what a physicist would do!

Press for Explanation:

27:24 – Pressing Liliana to add an explanation to her assertion about the big guy traveling farther – “Why would the big one travel farther?”

31:00 – Liliana is working her way towards an explanation for why it seems like the big passenger’s inertia shouldn’t be enough to overcome the weight and the gravity – she’s working on explaining why it seems like the big passenger SHOULD NOT roll as far as it did.

Meanwhile, from the next group over, Hilina makes a joke about how it’s always “why, why, why in this class! She’s just going to keep on saying it!” – I guess that is one way to know when a practice has been incorporated as a norm in your science classroom culture – it becomes the subject of students’ jokes!

Teacher
commentary from
14:26 → 19:43

Visiting Yael, Liliana,
Shawna, Amy in
order to have a
round of talk focused
on IDEAS instead of
procedures.

Questions I use to help kids say more:

Re-orienting students to their initial hypotheses and getting students talking about the physics IDEAS instead of the material procedures:

14:37 – “When you guys talked about your models earlier, did you think that the big guy would act differently than the little guy?”

Pressing students to expand their hypotheses/mental models:

16:14 – “Well, what about the inertia of being ‘in motion’ – doesn’t more mass mean that it will have more inertia when it’s in motion?”

Other important discourse moves:

15:39 – I make sure that I invite Liliana to contribute her idea – she and Yael were competing for air time earlier and I don’t want to silence her ideas especially since I let the boy in the group speak first.

16:00 – I make sure to invite Amy to contribute something since she hasn’t been speaking so far in this episode.
