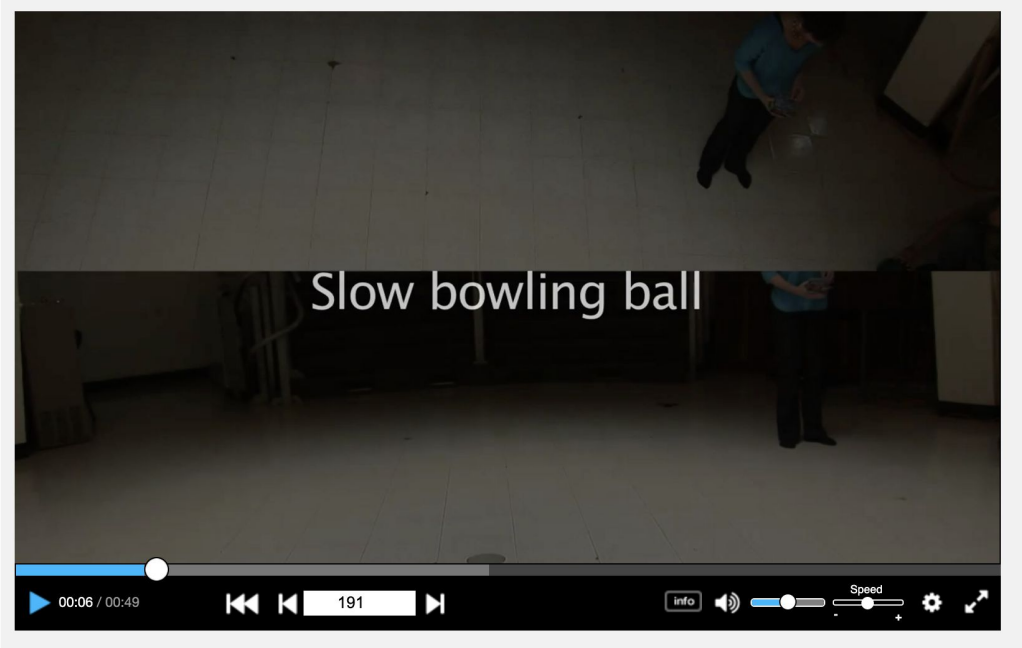
Physics Education Laboratory
Lecture 07
PCK for Dynamics

Francesco Longo - 18/10/23

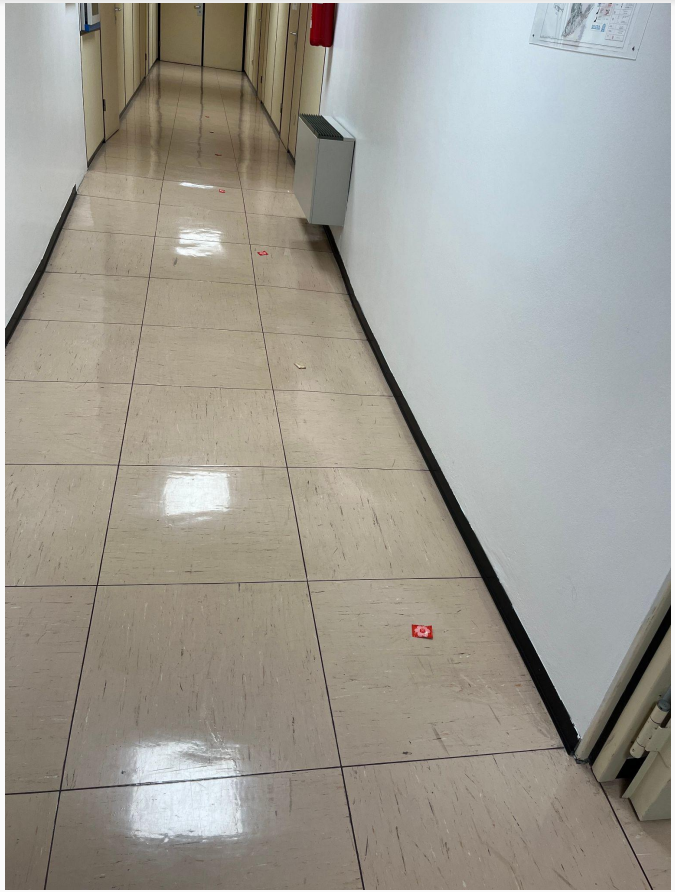


a. What patterns did you notice in the placement of the dots?

b. How can you use the distances between the dots to describe the motion of the bowling ball?

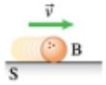
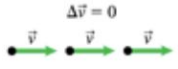
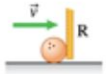
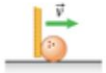
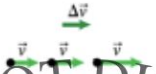
https://mediaplayer.pearsoncmg.com/assets/_frames.true/secs-experiment-video-1

Laboratory on Dynamics



Observational Experiment Table 3.1

How are motion and forces related?

Observational experiment	Analysis: Motion diagram
Experiment 1. A bowling ball B rolls on a very hard, smooth surface S without slowing down. 	
Experiment 2. A ruler R lightly pushes the rolling bowling ball opposite the ball's direction of motion. The ball continues to move in the same direction, but slows down. 	
Experiment 3. A ruler R lightly pushes the rolling bowling ball in the direction of its motion. The ball speeds up. 	

Pattern

- In all the experiments, the vertical forces add to zero and cancel each other. We consider only forces exerted on the ball in the horizontal direction.
- In the first experiment, the sum of the forces exerted on the ball is zero; the ball's velocity remains constant.
- In the second and third experiments, when the ruler pushes the ball, the velocity change arrow ($\Delta\vec{v}$ arrow) points in the same direction as the sum of the forces.

Summary: The $\Delta\vec{v}$ arrow in all experiments is in the same direction as the sum of the forces. Notice that there is no pattern relating the *direction* of the velocity $\vec{v}$ to the direction of the sum of the forces. In Experiment 2, the velocity and the sum of the forces are in opposite directions, but in Experiment 3, they are in the same direction.

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How are motion and forces related?

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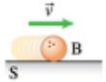
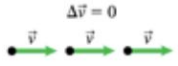
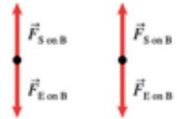
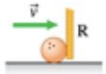
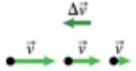
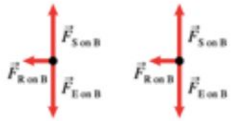
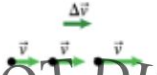
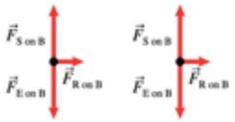
Experiment 1. A bowling ball B rolls on a very hard, smooth surface S without slowing down. 		
Experiment 2. A ruler R lightly pushes the rolling bowling ball opposite the ball's direction of motion. The ball continues to move in the same direction, but slows down. 		
Experiment 3. A ruler R lightly pushes the rolling bowling ball in the direction of its motion. The ball speeds up. 		

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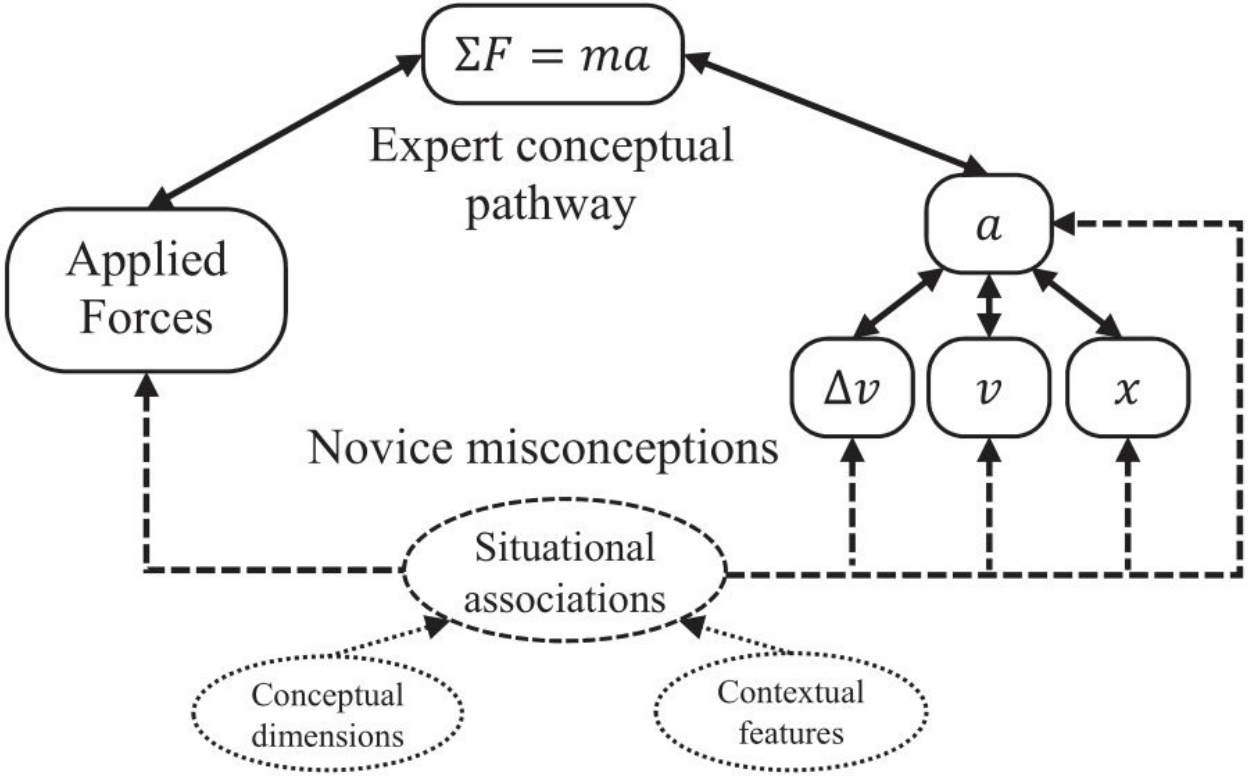
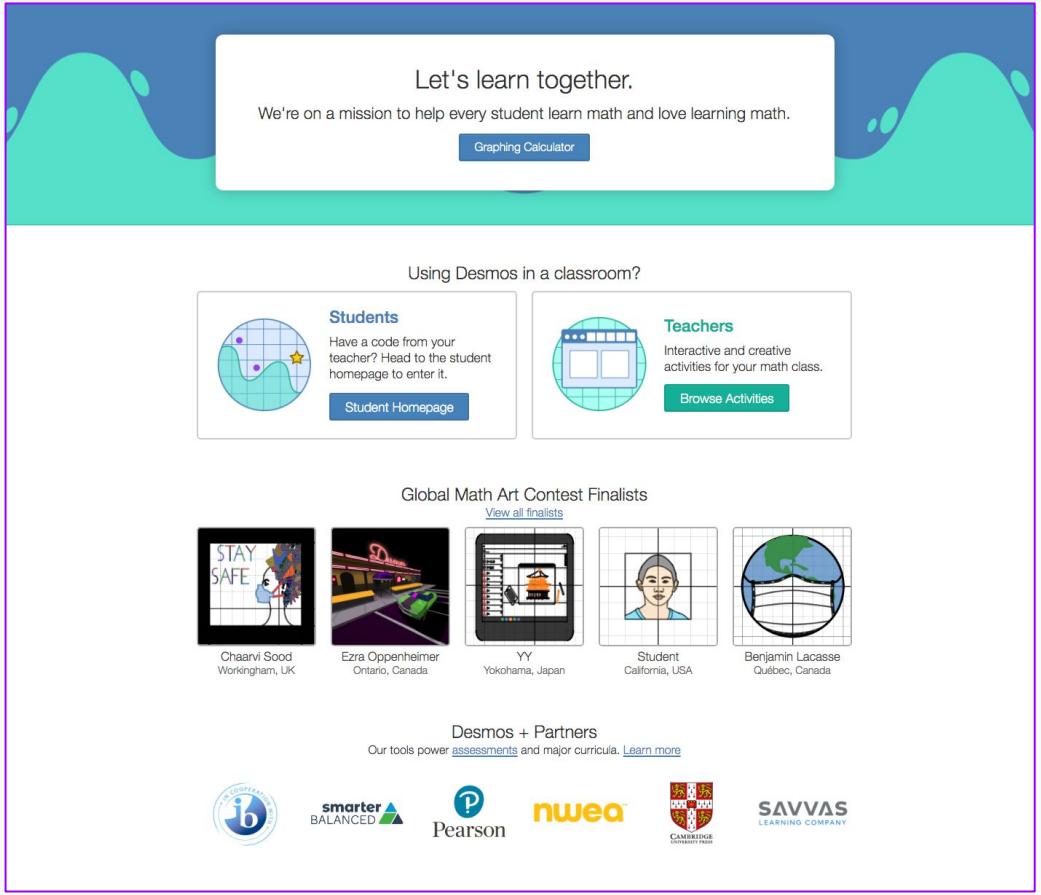


Figure 1. Conceptual framework of force and motion showing connections among variables, relations, and conceptual ideas. The two-way arrows indicate possible pathways of connections within a learner's knowledge structure. The solid lines represent experts' conceptual pathway, while the dashed lines represent novices' possible pathways.

Teacher Desmos: a useful tool …

https://teacher.desmos.com



Teacher Desmos: a useful tool …

What We Do

Desmos wants to build a world where every student learns math and loves learning math, where a student's access to the power and beauty of math doesn't depend on their place of birth, race, ethnicity, gender, or any other aspect of their identity.

Our free suite of math software tools, including the renowned Desmos Graphing Calculator and Scientific Calculator, are used annually by over 40 million teachers and students around the world. Our tools power core math curricula for many of the world's largest publishers, and our calculators are built into the majority of U.S. state-level assessments and digital college entrance exams. Desmos is also partnered with the Smarter Balanced Assessment Consortium, the International Baccalaureate MYP, and NWEA (view the full list of assessments here).

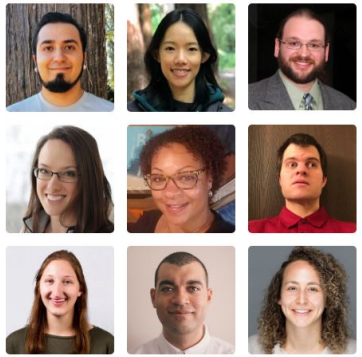
Our cutting-edge technology also powers our free digital classroom activities, thoughtfully designed by teachers for teachers to support and celebrate the different ways students come to know mathematics. These activities are guided by our pedagogical philosophy and open up a world of possibilities for students to explore concepts more deeply, collaborate with their peers on problem-solving, and apply knowledge creatively as mathematicians.

In 2020, we launched our core middle school math program, which pairs the open-source U.S. middle school curriculum from Illustrative Mathematics and Open Up Resources with Desmos' powerful technology, humanizing pedagogy, and intuitive design. We are working with an incredible cohort of schools and districts to implement and further improve this program over the years to come.

Come join us on our journey! Play with the calculator, check out our classroom activities, or find a career on our growing team. Stay in touch with us on Twitter, Facebook, Instagram, or email. Teachers and school leaders are also welcome to join our Educators Community.

Who We Are

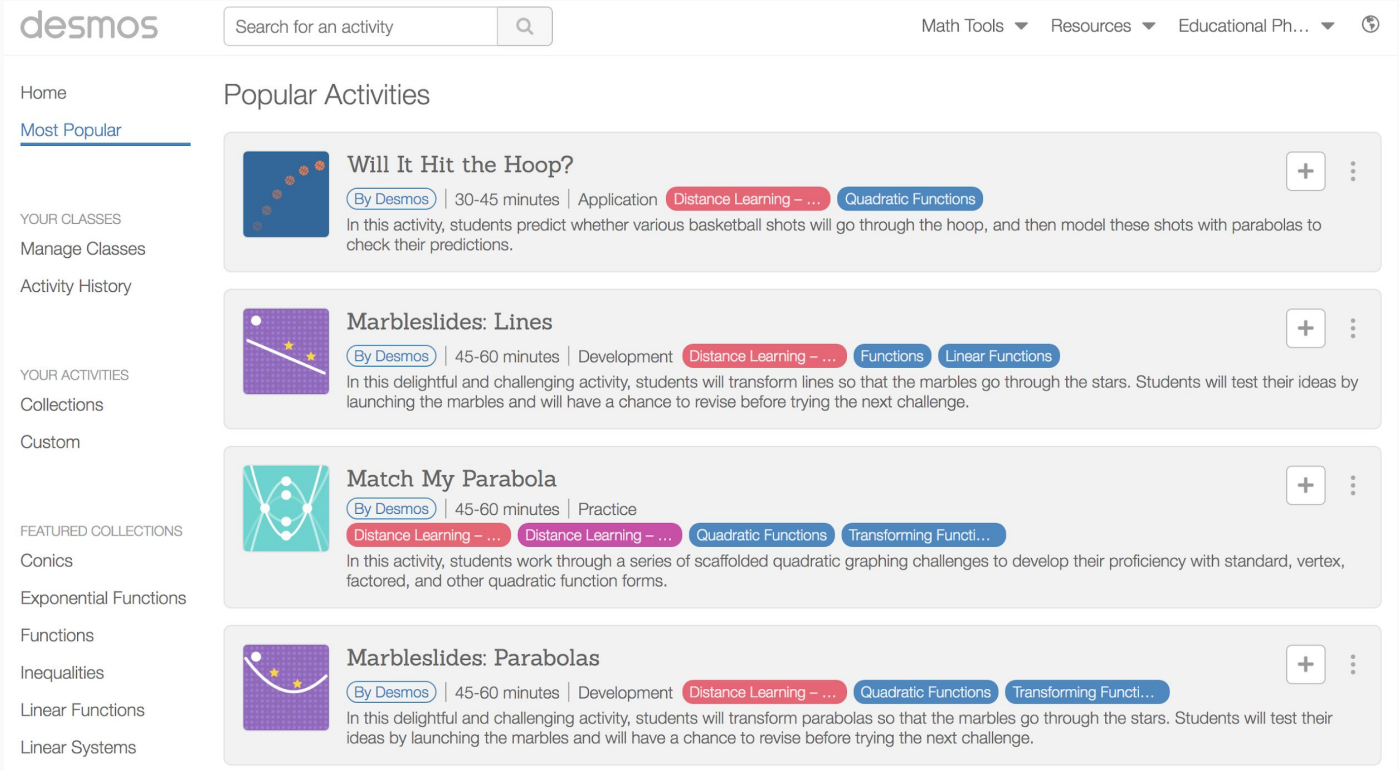
Meet the Team



We're a small but growing team.
Interested in joining? We're hiring! ›

https://teacher.desmos.com

Teacher Desmos: a useful tool …



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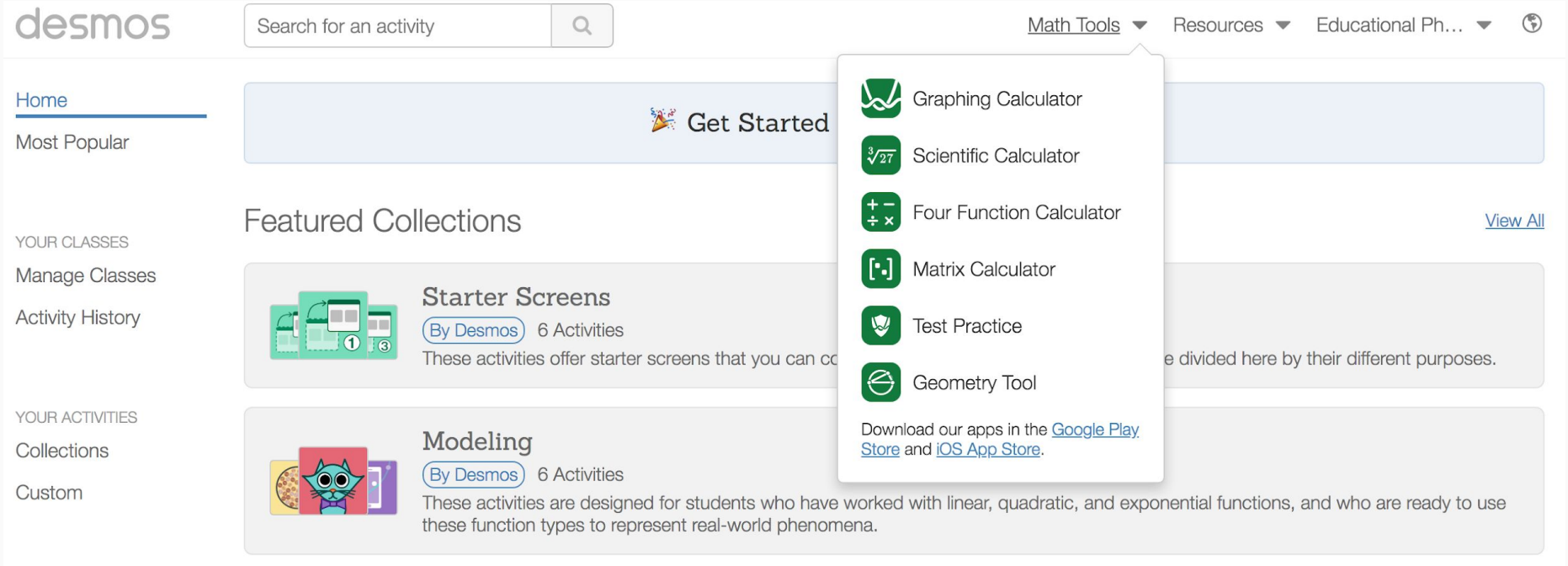


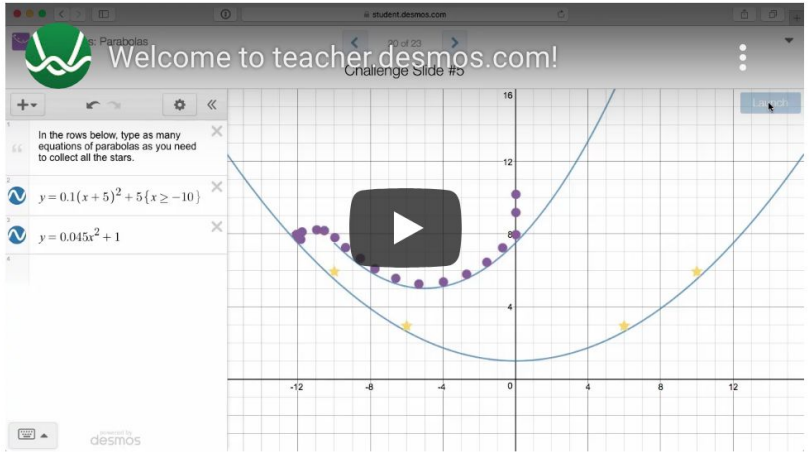
https://teacher.desmos.com

Teacher Desmos: a useful tool …

Learn Desmos: Classroom Activities

At Desmos, our mission is to help every student learn math and love learning math. With that in mind, we've assembled a collection of unique and engaging digital activities. And best of all? Everything you see at teacher.desmos.com is free. Get started with the video on the right, then dive deeper with the resources below.

Tips for Getting Started



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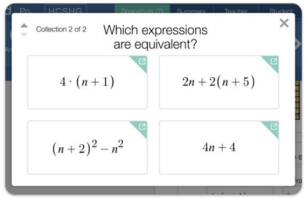
Teacher Desmos: a useful tool …

Next Steps

Facilitate Class Conversations

Learn how to facilitate Desmos activities like a pro with our **Classroom Conversation** features—Anonymize, Teacher Pacing, and Pause Class.

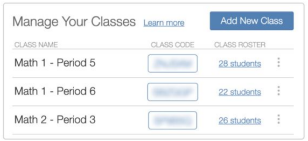


Select and Sequence Student Work

The Desmos teacher dashboard collects a *lot* of student ideas. Use our **Snapshots** tool to select and sequence those ideas as you orchestrate class discussions around student thinking.

Send Feedback to Students

Leave **Written Feedback** on any student screen. Students will see your comment and develop their mathematical ideas further.

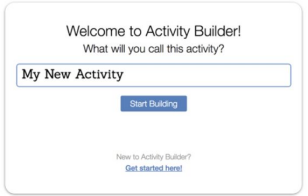


Manage Your Classes

Create classes to assign activities to the same group of students throughout a school term.

Add Co-teachers

Co-teaching is easy in Desmos when you and your co-teacher are both near the same computer. But when you're far from each other, you can *still* collaborate.



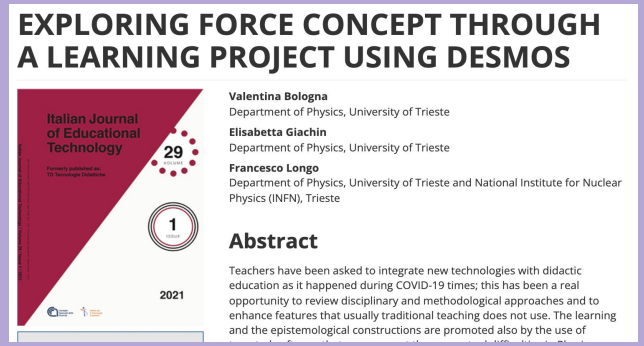
Create Custom Activities

Create your own Desmos-powered activities with our custom **Activity Builder**. Learn the ropes with our collection of video tutorials and editable sample activities.

https://teacher.desmos.com

LE FORZE

Percorso didattico per la classe seconda della scuola secondaria di primo grado



EXPLORING FORCE CONCEPT THROUGH A LEARNING PROJECT USING DESMOS

Italian Journal of Educational Technology

29

1

2021

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Abstract

Teachers have been asked to integrate new technologies with didactic education as it happened during COVID-19 times; this has been a real opportunity to review disciplinary and methodological approaches and to enhance features that usually traditional teaching does not use. The learning and the epistemological constructions are promoted also by the use of

https://ijet.itd.cnr.it/article/view/1190

UNIVERSITÀ DEGLI STUDI DI TRIESTE

DIPARTIMENTO DI FISICA

Corso di Laurea Triennale in Fisica

Sviluppo di un percorso didattico innovativo sul concetto newtoniano di forza

Laureanda:
Elisabetta GIACHIN

Relatore:
Prof. Francesco LONGO

Correlatrice:
Prof.ssa Valentina BOLOGNA

ANNO ACCADEMICO 2019/2020

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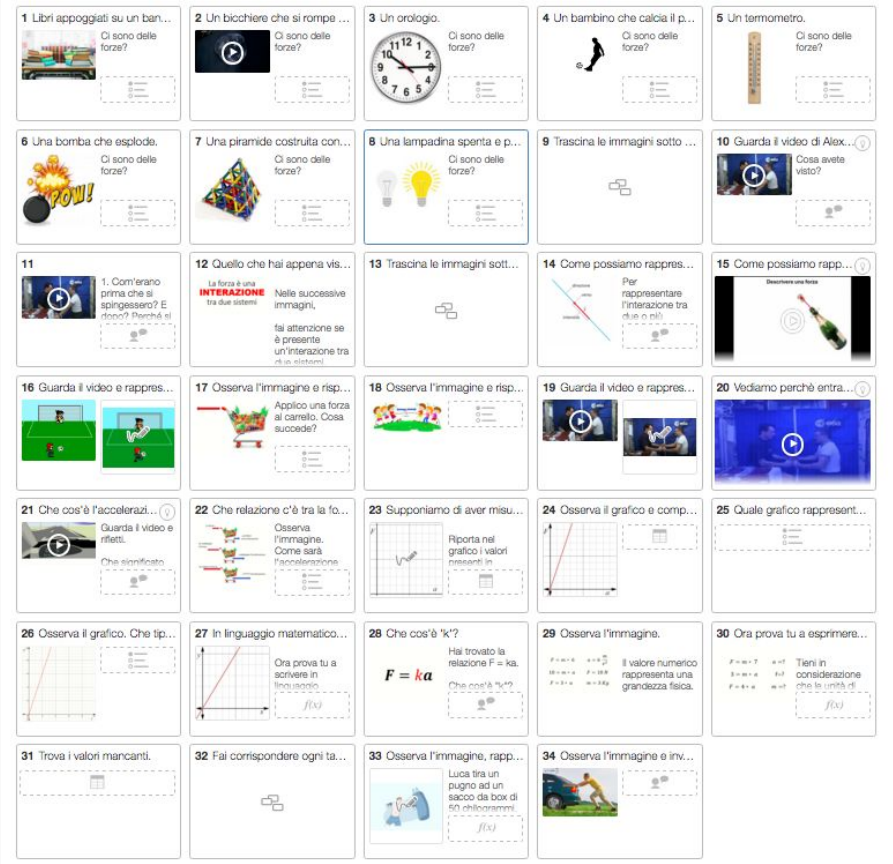

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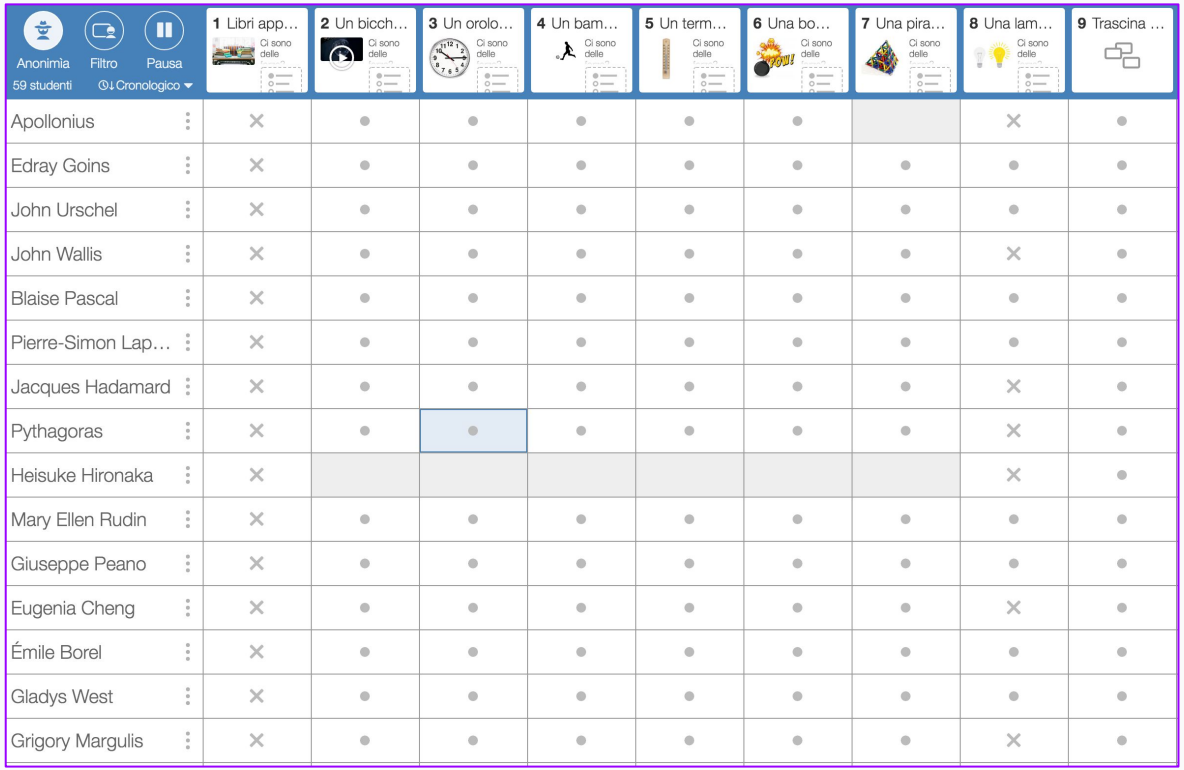


https://teacher.desmos.com/activitybuilder/custom/5e54caa8204160426dea0d43?lang=it

ANTEPRIMA DELLA SCHERMATA DELLO STUDENTE

Libri appoggiati su un banco di scuola.

Ci sono delle forze?

SI | NO

Misconception: what about net forces?

Un bicchiere che si rompe per effetto del suono.

Ci sono delle forze?

SI | NO

Un bambino che calcia il pallone.

Ci sono delle forze?

SI | NO

Una piramide costruita con dei magneti.

Ci sono delle forze?

SI

Una bomba che esplode.

Ci sono delle forze?

SI | NO

Un termometro.

Ci sono delle forze?

SI | NO

Una lampadina spenta e poi accesa.

Ci sono delle forze?

SI | NO

Un orologio.

Ci sono delle forze?

SI

Try to understand which are the prior/intuitive students' knowledge: What is a force?

Trascina le immagini sotto al cartellino corretto.

Esempi di NON Forza

Esempi di Forza

Collecting informations → create a disatisfaction because the student is not sure of his answers...

Guarda il video di Alexander e Pedro, due astronauti nello spazio, e rispondi.

Cosa avete visto?

Condividi con la classe

1. Com'erano prima che si spingessero? E dopo? Perché si sono mossi?

2. Cos'è cambiato dopo la spinta? Ha cambiato posizione solo uno dei due o si sono spostati entrambi?

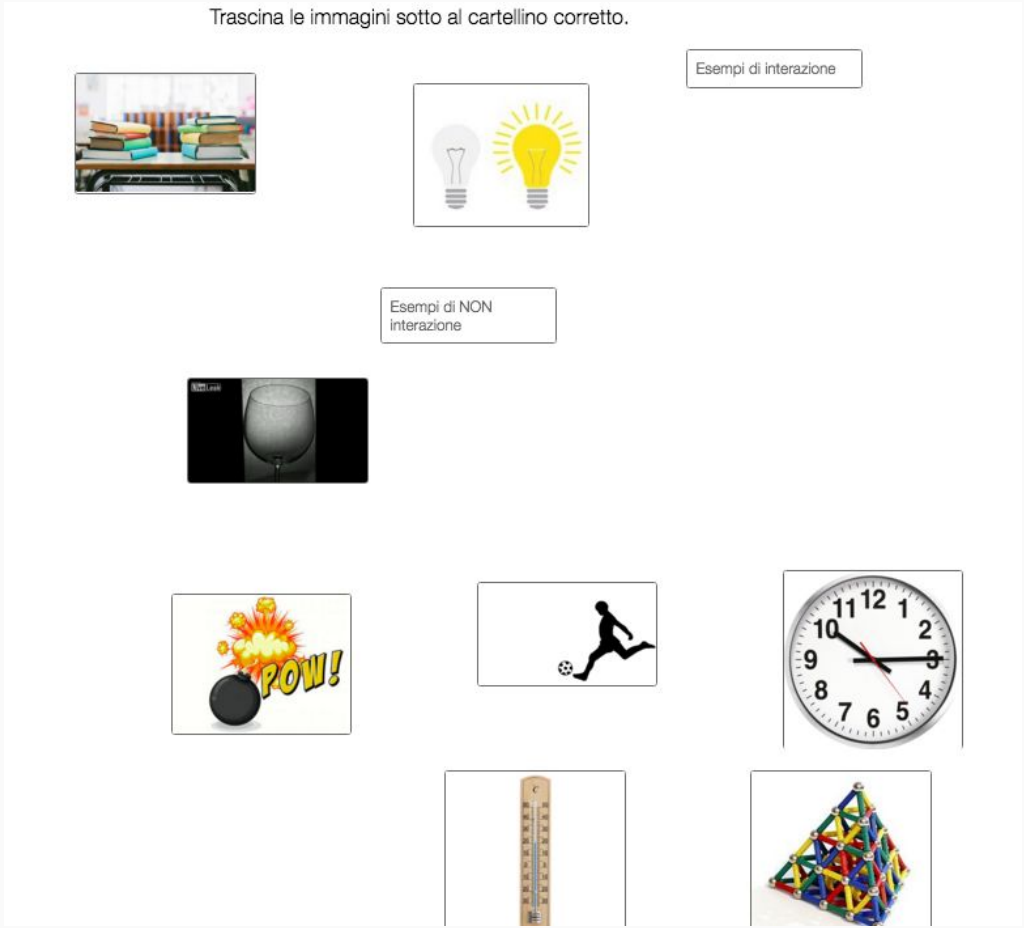
Condividi con la classe

Quello che hai appena visto è un esempio di interazione.

La forza è una
INTERAZIONE
tra due sistemi

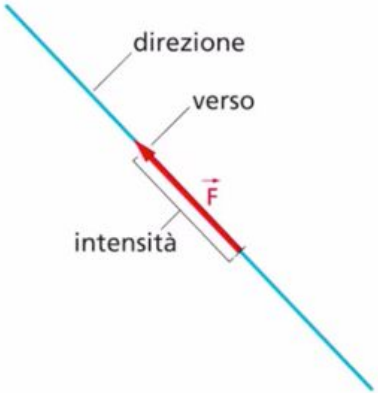
Nelle successive immagini,

fai attenzione se è presente un'interazione tra due sistemi.



The same images but another request: not forces but interactions

Come possiamo rappresentare la forza?



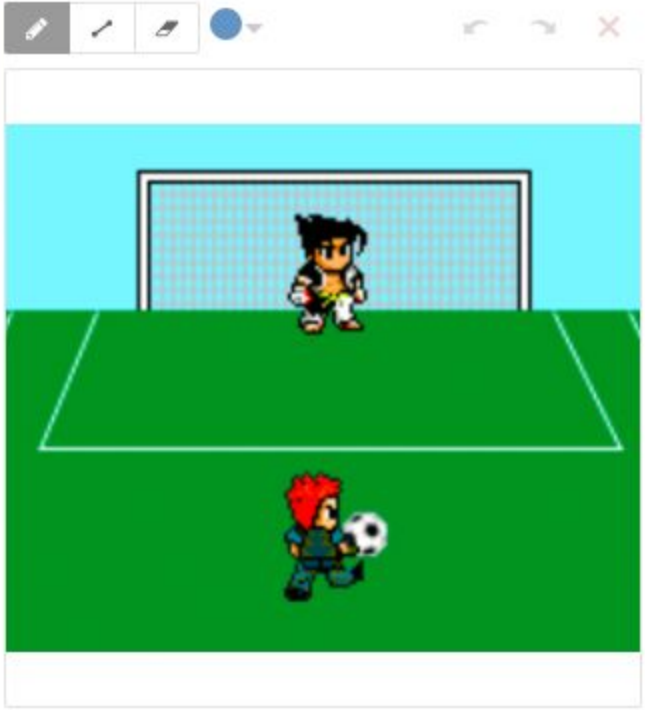
Per rappresentare l'interazione tra due o più oggetti, scegliamo di utilizzare una FRECCIA.

Osserva l'immagine. Che cosa caratterizza la freccia?

Condividi con la classe

Come possiamo rappresentare la forza?

Guarda il video e rappresenta con una freccia la forza applicata sul pallone.



Osserva l'immagine e rispondi.

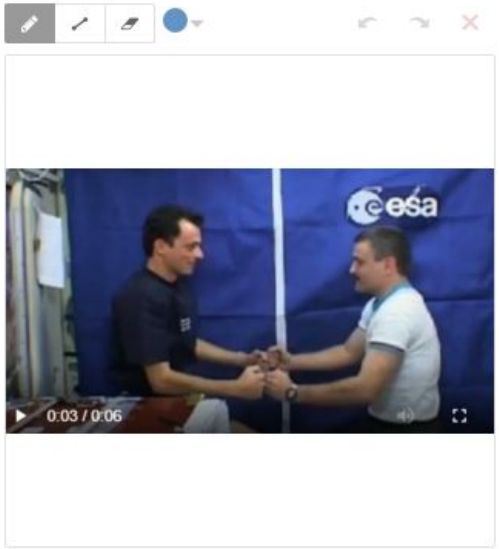
Applico una forza al carrello. Cosa succede?

- ○ Il carrello si sposta verso destra.
- ○ Il carrello rimane fermo.
- ○ Il carrello si sposta verso sinistra.

Osserva l'immagine e rispondi.

- ◯ Le due squadre esercitano due forze uguali e contrarie.
- ◯ La squadra di destra esercita una forza maggiore.
- ◯ La squadra di sinistra esercita una forza minore.

Guarda il video e rappresenta con due frecce di colore diverso le due forze esercitate da Alexander e Pedro.



Vediamo perchè entrambi si muovono.

Che cos'è l'accelerazione?

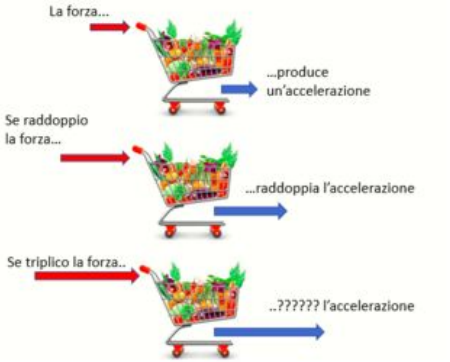
Guarda il video e rifletti.

Che significato ha la tabella del video? La macchina parte da ferma e per raggiungere la velocità di 40 m/s, ad ogni istante varia la sua velocità.

Da che cosa è causata l'accelerazione?

Condividi con la classe

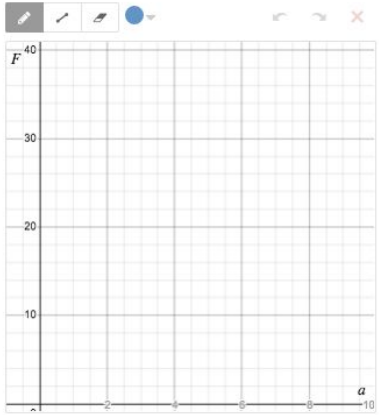
Che relazione c'è tra la forza e l'accelerazione?



Osserva l'immagine. Come sarà l'accelerazione quando triplico la forza?

- L'accelerazione si dimezza.
- L'accelerazione triplica.
- L'accelerazione diminuisce.

Supponiamo di aver misurato i valori di forza e accelerazione applicati al carrello.

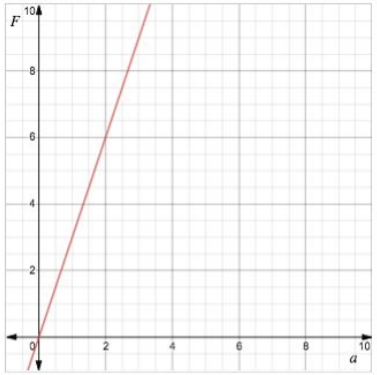


Riporta nel grafico i valori presenti in tabella.

Unisci i punti rappresentati nel grafico con una linea.

a (m/x^2)	F (N)
0	0
1	10
2	20
3	30
4	40

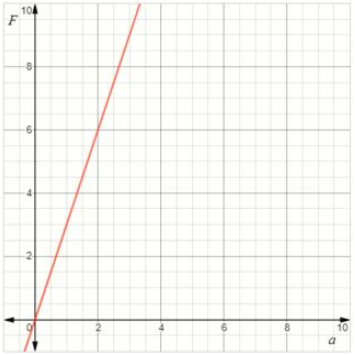
Osserva il grafico e completa la tabella.



a (m/s^2)	F(N)
0	
1	
	6
3	

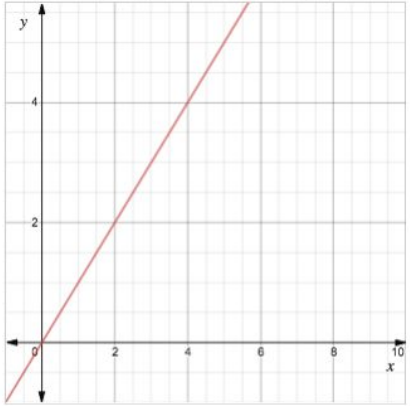
Quale grafico rappresenta meglio la relazione tra forza e accelerazione?

Osserva il grafico. Che tipo di proporzionalità c'è tra forza e accelerazione?



- Proporzionalità diretta (aumenta l'accelerazione, aumenta la forza)
- Proporzionalità inversa (aumenta l'accelerazione, diminuisce la forza)

In linguaggio matematico la proporzionalità diretta si esprime con la relazione y=kx



Ora prova tu a scrivere in linguaggio matematico la relazione che c'è tra la forza e l'accelerazione.

Condividi con la classe

Che cos'è 'k'?

$F = ka$

Hai trovato la relazione F = ka.

Che cos'è "k"? La MASSA (m).

Riscrivi la relazione tra forza e accelerazione tenendo conto di cos'è k.

Condividi con la classe

Osserva l'immagine.

Il valore numerico rappresenta una grandezza fisica.

$F = m * 6$ $a = 6\ \frac{m}{s^2}$

$10 = m * a$ $F = 10\ N$

$F = 3 * a$ $m = 3\ Kg$

Ora prova tu a esprimere il valore numerico della grandezza fisica.

$F = m * 7$ $a = ?$

$3 = m * a$ F=?

$F = 4 * a$ $m = ?$

Tieni in considerazione che le unità di misura sono:

Newton (N) per la forza,

chilogrammo (Kg) per la massa,

metro al secondo quadrato (m/s^2) per l'accelerazione.

Condividi con la classe

Trova i valori mancanti.

F(N)	m (kg)	a (m/s^2)
10		5
6	3	
	1	10
4		2
	6	4
12	4	
1		1

Fai corrispondere ogni tabella alla rispettiva rappresentazione grafica e in linguaggio matematico

F=1a

F=5a

Osserva l'immagine, rappresenta le forze e rispondi.

Luca tira un pugno ad un sacco da box di 50 chilogrammi. Sapendo che il sacco si sposta con un'accelerazione di 5 m/s^2, che forza dovrà applicare Luca per farlo muovere?

Condividi con la classe

Osserva l'immagine e inventa il testo del problema.

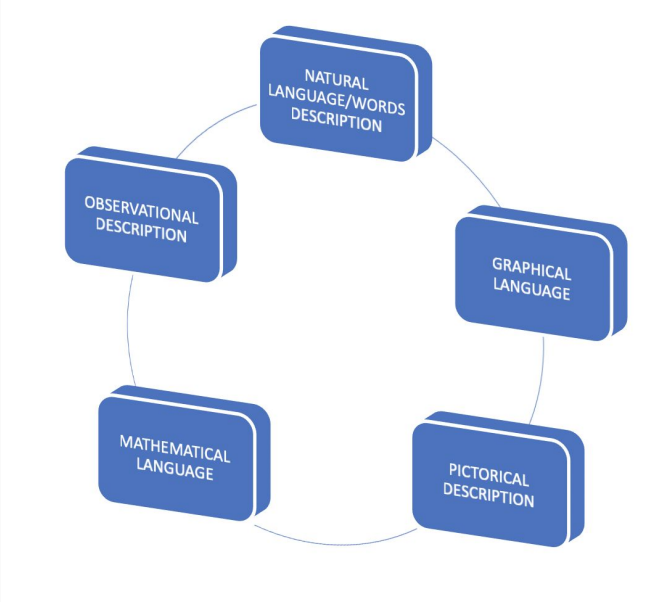
Condividi con la classe

Knowledge pieces useful for problem solving and Jeopardy problems

What changes will you suggest for a first year course in a scientific high school?

Kinematics and dynamics concept integration

Rotational Motion DESMOS EDUCATIONAL LABORATORY



ACTIVITY 1: Observe the phenomena

https://teacher.desmos.com/activitybuilder/custom/61827677ea59770a1ada8332

ACTIVITY 2: Represent the phenomena

https://teacher.desmos.com/activitybuilder/custom/6182738298fcb5dbfae73882

ACTIVITY 3: Integrate languages/descriptions

https://teacher.desmos.com/activitybuilder/custom/618277f16591badbf9ee0fbe

Genuine understanding is most likely to emerge...if people possess a number of ways of representing knowledge of a concept or skill and can move readily back and forth among these forms of knowing.

(Gardner, 1991)