Confronting Student Misconceptions

A professional development session for STEM Educators

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Misconception #1 - identification and origins

- Inspired by an example where a student wrote “½ = 2” and the cause was identified as “the student thinks that mathematics is only made up of numbers” (Mesutoğlu and Birgili, 2017, p. 532)
- Parallel example in older students: “$2^4 = 8$” (Ulusoy, 2019, p. 59), a possible cause being “the student thinks that exponentiation is just an alternative form of multiplication notation”.

Misconception #1 - restructuring strategies

Figure 1

Activity that helps students make connections between exponential representations

3^{-3}		$\frac{1}{27}$	
3^{-2}	$\frac{1}{3 \cdot 3}$		
3^{-1}			
3^{0}			
3^{1}	3	3	
3^{2}	$3 \cdot 3$	9	
3^{3}	$3 \cdot 3 \cdot 3$	27	

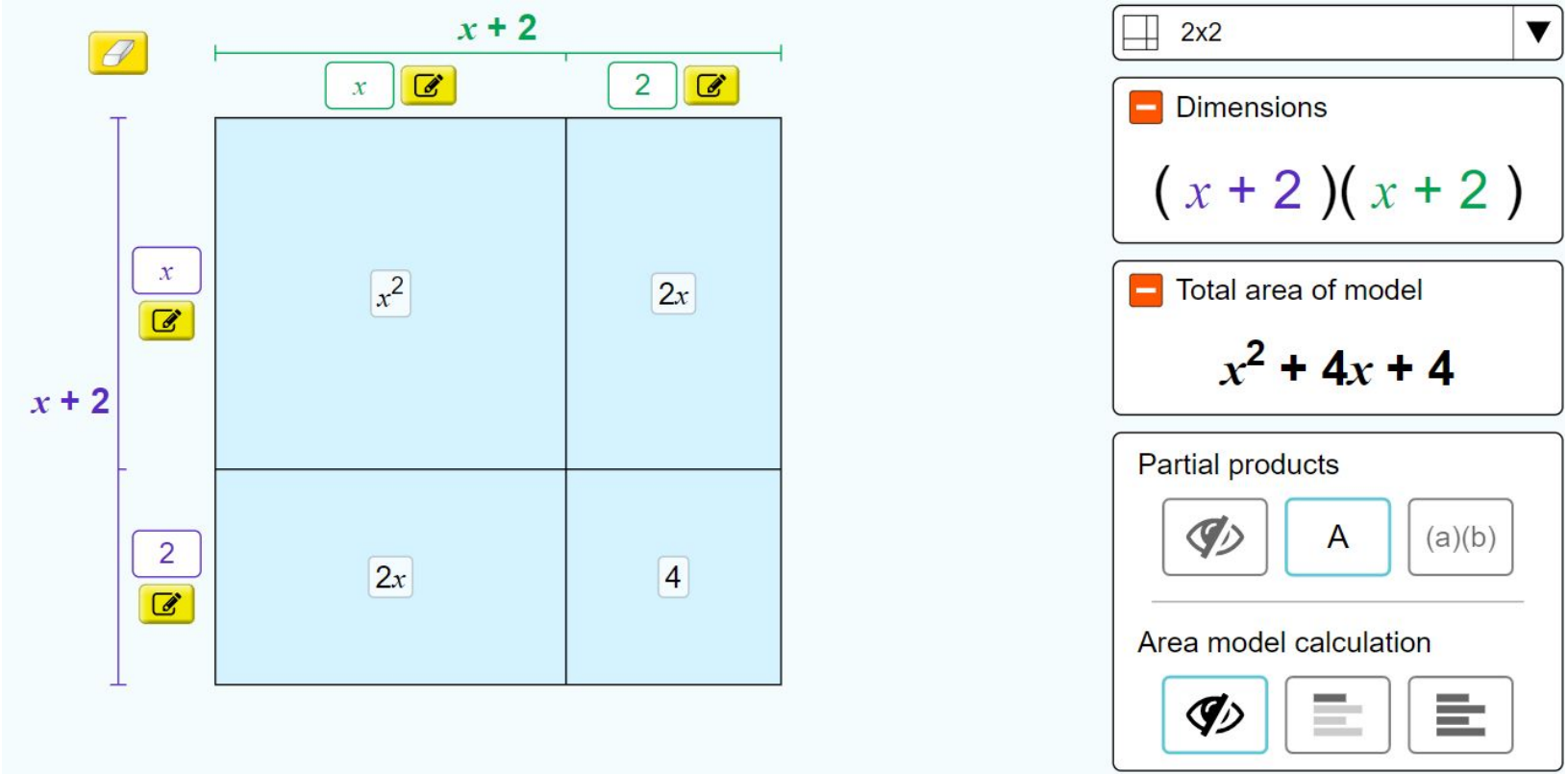
Graph 3^x

Note. Adapted from *Exploring Exponents - YouCubed* (2020).

Misconception #1 - restructuring strategies

Figure 2

Interactive visual that reminds students of the connection between squaring and area



Note. Adapted from *Area Model Algebra* (n.d.).

Misconception #1 - bigger picture connections

Graphing $y = 3^x$ prompt can lead to using technology to generate tables of values and scatter plots of exponential patterns - develops 21st century skills

"The greatest shortcoming of the human race is our inability to understand the exponential function." (Bartlett, 1969)

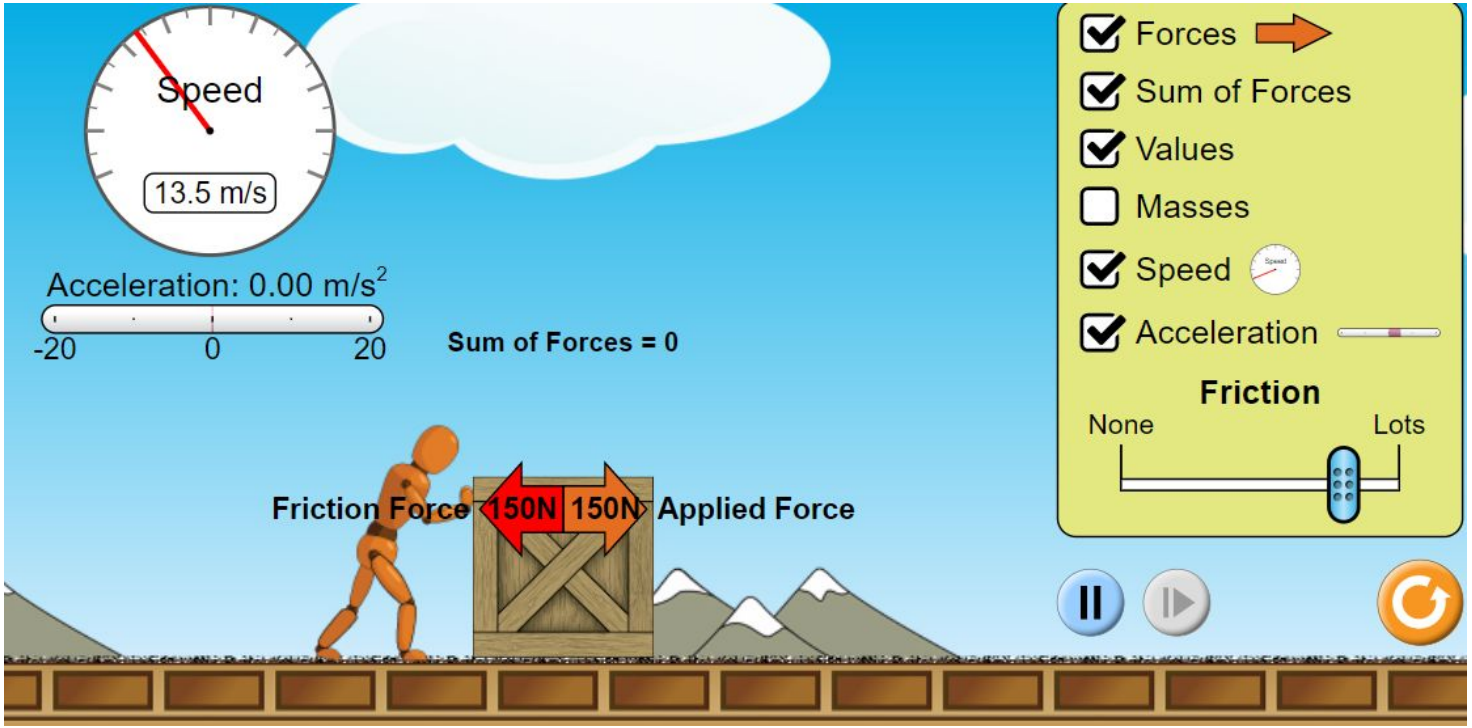
Misconception #2 - identification and origins

- Thinking that an object requires a net force to remain in motion - inspired by Robertson's "Five E's" example of how to help students understand that acceleration can be a change in the speed OR direction of a moving object (2018, p. 72)
- According to physicsclassroom.com (The Big Misconception, n.d.) this still happens centuries after Galileo and Newton's discoveries because it conflicts with our everyday experience - in other words, students understand it in an abstract sense, but they don't *believe* it.

Misconception #2 - restructuring strategies

Figure 3

Interactive simulation demonstrating how speed can be non-zero when the net force acting is zero



Note. Adapted from *Forces and Motion: Basics* (n.d.).

Misconception #2 - restructuring strategies

Figure 4

Series of inquiry-based, hands-on lessons to help younger learners understand Newton's Laws

Note. Adapted from Aerospace Education Services Project (2012).

Misconception #2 - bigger picture connections

Students can gain experience using motion sensors or doing video tracking of objects

Although theoretically superseded by quantum physics and relativity, understanding Newtonian mechanics is still fundamental to most of the practical science and engineering projects that people are working on today

Misconception #3 - identification and origins

- Thinking that heavier objects are more affected by gravity than lighter ones. Even many non-science teachers retain this misconception (Mataka and Taibu, 2019).
- Why? “folk science, widely-shared but faulty assumptions about how the physical world works.” (Paul, 2012, para. 1)

Misconception #3 - restructuring strategies

Figure 5

Addressing the misconception that a ball will accelerate at a greater rate if thrown downwards

Note. Adapted from *Common Free-Fall Pitfalls* (n.d.).

Misconception #3 - restructuring strategies

Figure 6
An exemplar Multi-Step Inquiry (MSI) approach

MSI category	How it is addressed in free fall section
Pre-discussion	• Complete conceptual questions about free fall. • Groups present their conception to class. • Groups discuss how they can investigate different conceptions of free fall.
Experimentation/demonstration	• Working with balls to determine falling times. • Watching video on free fall • Observing a demonstration of free fall
Post-discussion	• Group and class discussions of the experiments and observations. • Revisiting pre-activity conceptual questions. • Discussing more questions prone to misconceptions in free fall in groups and as a class.
Misconception essay	• Inclusion of 3 questions on free fall on misconception essay 1.

Note. Adapted from Mataka and Taibu (2019).

Misconception #3 - bigger picture connections

- “Sometimes, learning something new requires ignoring what we already know — and not just in science.” (Paul, 2012, para. 5)
- Offers opportunity to discuss the Nature of Scientific Knowledge as described by Lederman et al. (2019)

References

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