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Force and Motion: An Integrated K-8 Hands-On Approach Supporting the NGSS and CCSS ELA

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Force and Motion (PS2):

An Integrated K–8 Hands-On Approach Supporting the *NGSS* and *ELA CCSS*

National Science Teachers Association Conference 2017

EAST TENNESSEE STATE UNIVERSITY

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Why Science and Literacy Integration?

NGSS Practices	CCSS ELA Practices
S1. Ask questions and define problems	**E1. Demonstrate independence in reading complex texts, and writing and speaking about them.**
S2. Develop and use models.	E2. Build a strong base of knowledge through content rich texts.
S3. Plan and carry out investigations.	E3. Obtain, synthesize, and report findings clearly and effectively in response to task and purpose.
S4. Analyze and interpret data.	**E4. Construct viable arguments and critique reasoning of others.**
S5. Use mathematics and computational thinking.	**E5. Read, write, and speak grounded in evidence.**
S6. Construct explanations and design solutions.	E6. Use technology and digital media strategically and capably.
S7. Engage in argument from evidence.	E7. Come to understand other perspectives and cultures through reading, listening, and collaborating
S8. Obtain, evaluate and communicate evidence.	

Preparing College/Career Readiness through Integrating Science Learning with Literacy in Grades 4-12 (~~6-12~~)

A LEA-IHE-Business Partnership Initiative Supported by TN DOE MSP and THEC ITQ Grants (2015-18)

Local Education Agents

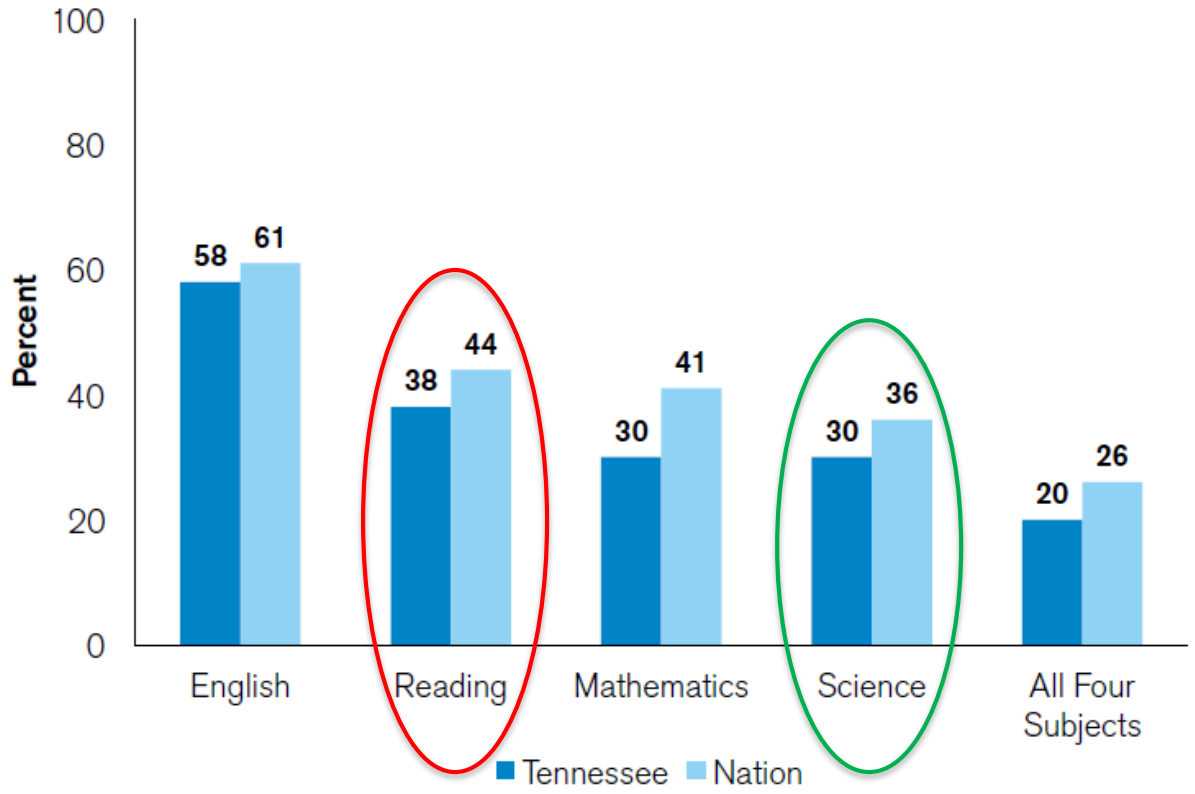
Institute of Higher Ed

Business Partners

EAST TENNESSEE STATE UNIVERSITY

Picture of College Readiness

Percent of 2016 ACT-Tested High School Graduates Meeting ACT College Readiness Benchmarks by Subject



Research Questions

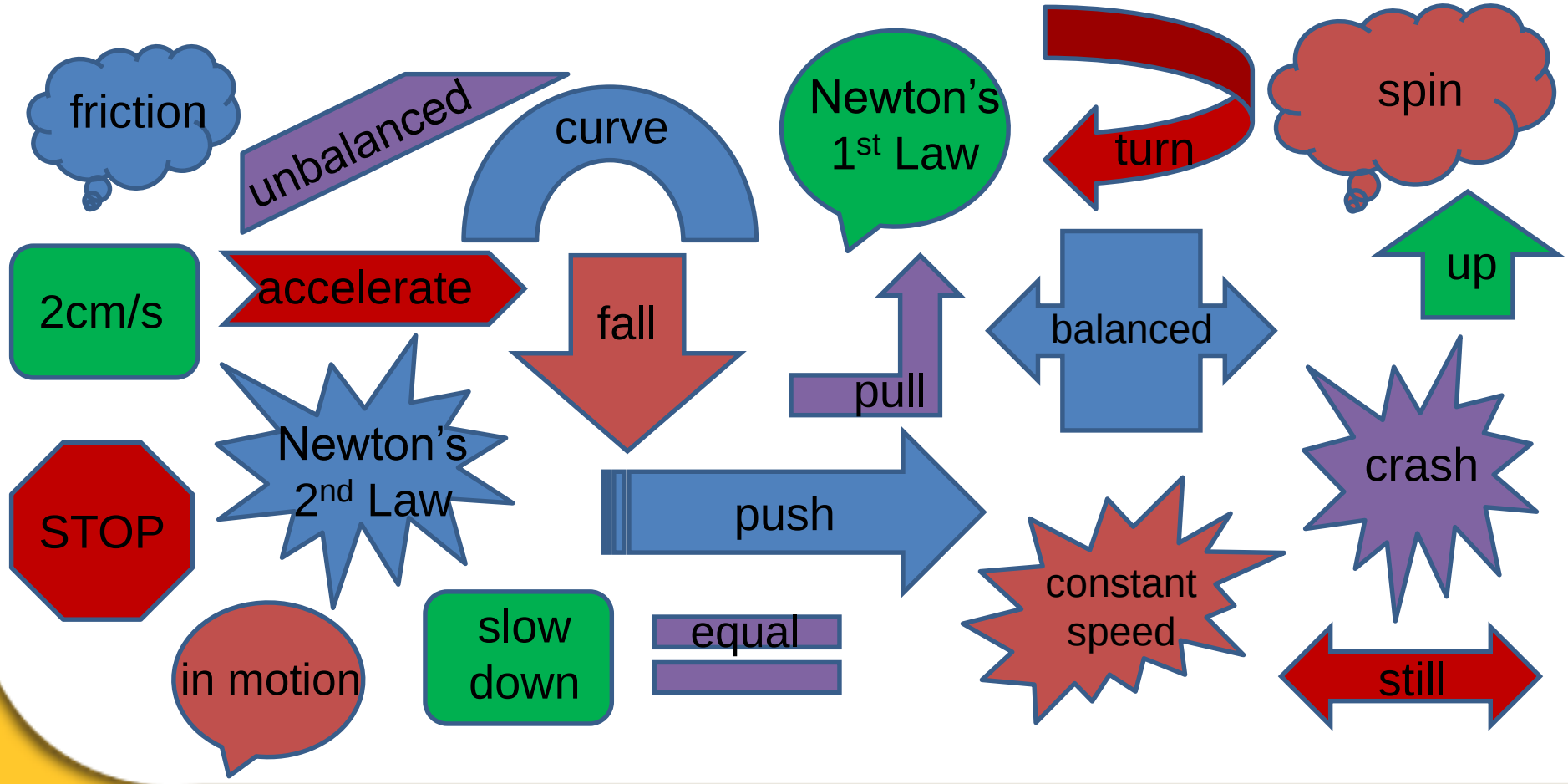
- **RQ1**: How does cross-discipline instruction benefit and enrich each subject discipline?
- **RQ2**: How does integration of science learning with literacy in G4-12 impact students' learning in schools?

Word Splash

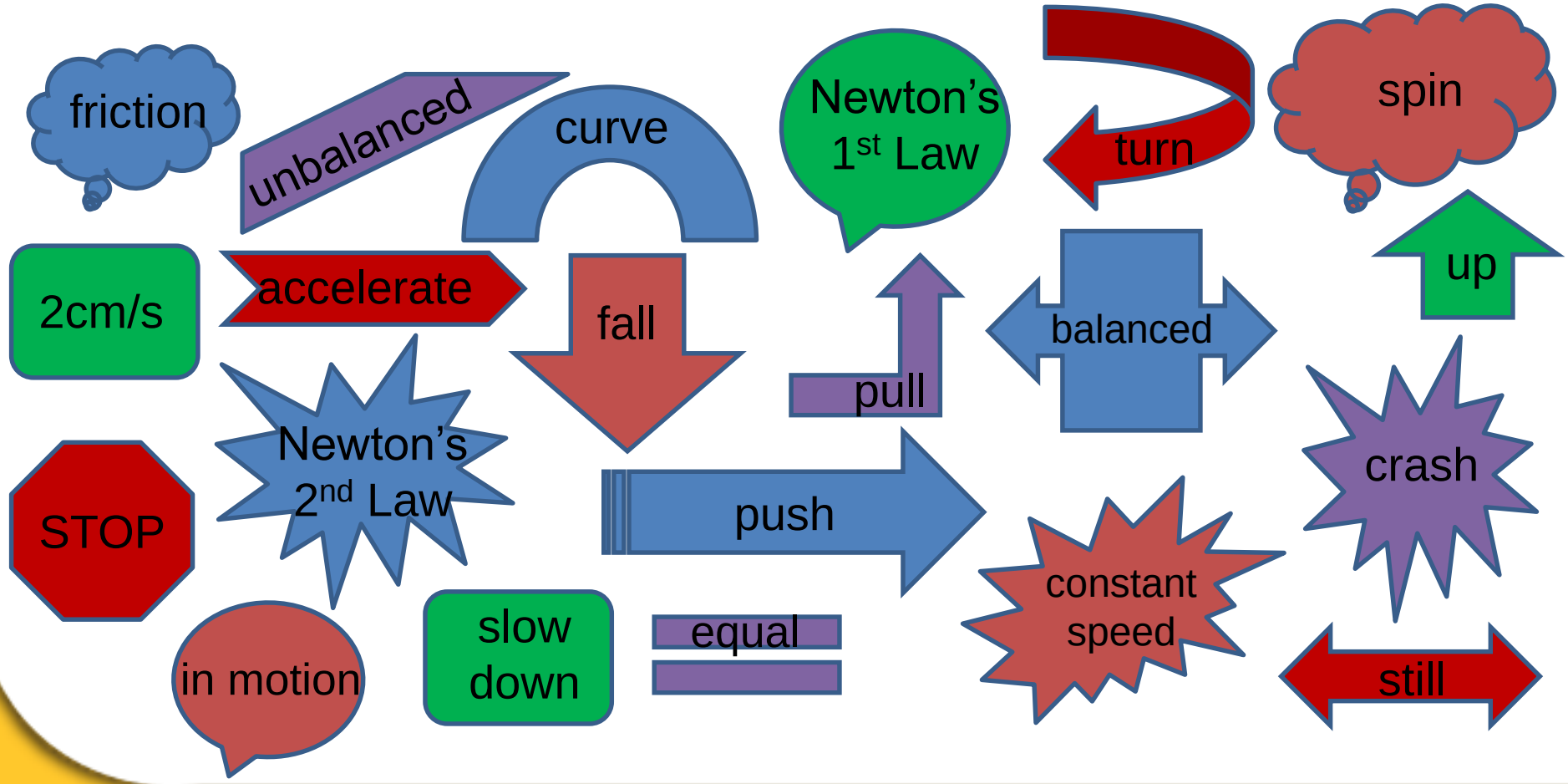
- Comprehension and vocabulary strategy
- Interactive activity that engages and motivates
- Sets a clear purpose for learning

(Burns, 2006)

Use the materials in your bag to demonstrate the following words.



Sort the words into two categories of forces: balanced forces & unbalanced forces.



Which claim(s) can be supported with evidence?

Claim 1

- Balanced = not moving
- Unbalanced = moving

Claim 2

- Balanced = no change in motion
- Unbalanced = change in motion

Claim 3

- Balanced = zero net force
- Unbalanced ≠ zero net force

NGSS Performance Expectations

3rd Grade

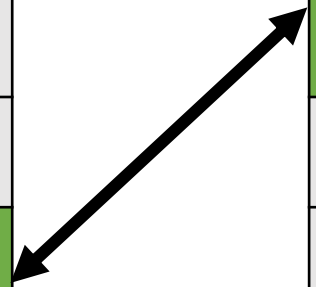
- 3-PS2-1. ***Plan and conduct an investigation to provide evidence*** of the effects of balanced and unbalanced forces on the motion of an object.
- 3-PS2-2. ***Make observations and/or measurements*** of an object's motion ***to provide evidence*** that a pattern can be used to predict future motion.

Middle Grades

- MS-PS2-1. Apply Newton's Third Law ***to design a solution to a problem*** involving the motion of two colliding objects.
- MS-PS2-2. ***Plan an investigation to provide evidence*** that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

Pairing ELA and Science Practices

CCSS ELA Practices	NGSS Science Practices
E1.Demonstrate independence in reading complex texts, and writing and speaking about them.	S1. Ask questions and define problems.
E2. Build a strong base of knowledge through content rich texts.	S2. Develop and use models.
E3. Obtain, synthesize, and report findings clearly and effectively in response to task and purpose.	**S3. Plan and carry out investigations.**
E4. Construct viable arguments and critique reasoning of others.	S4. Analyze and interpret data.
E5. Read, write, and speak grounded in evidence.	S5. Use mathematics and computational thinking.
E6. Use technology and digital media strategically and capably.	S6. Construct explanations and design solutions.
E7. Come to understand other perspectives and cultures through reading, listening, and collaborating.	S7. Engage in argument from evidence.
	S8. Obtain, evaluate and communicate evidence.



Acting Out Newton's Laws

- Video by Diana O'Neal

Newton's Three Laws of Motion

	Formula	Keywords/ Logic argumentation	Hands-on Activities
First Law	$\Sigma F = 0$	**Keywords:** Force: Balanced forces/ zero net forces Motion.: Inertia of motion (Status quo) **Argumentation:** Balanced net forces ⇒ constant motion (velocity = direction + speed)	• Wine glasses with different papers • Wine glasses with coins, paperboard
Second Law	$\Sigma F \neq 0$	**Keywords:** Force: Unbalanced forces/ non-zero net forces Motion: Change of motion **Argumentation:** Unbalanced net forces ⇒ motion change (direction and/or speed). The change also is proportional to mass.	• Motion detector- position, velocity, acceleration, time • Motion encoder system
Third Law	F_{action} $-F_{reaction}$	**Keywords:** F: Forces occur in pair Motion: Action on an object and Reaction on a subject **Argumentation:** Action is performed ⇒ reaction exists simultaneously equal in magnitude and opposite in direction.	• Balloon Jet activities • Skating board activities

Hands-on Activities for Newton's Three Laws

A. First Law

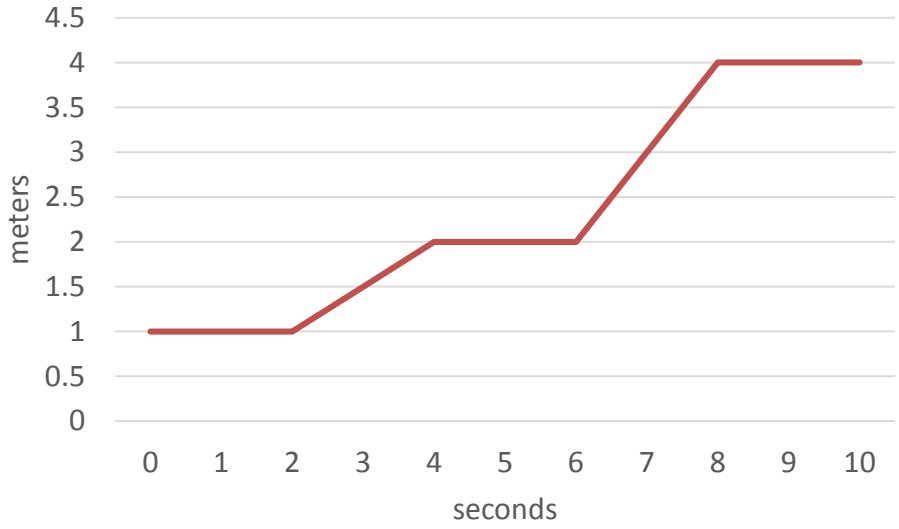
1. Wine glasses with different papers
2. Wine glasses with coins, paperboard

Hands-on Activities for Newton's Three Laws

B. Second Law

1. Motion detector: **position**, velocity, acceleration, **time**

Task one: Describe the movement and perform it.



Task Two:

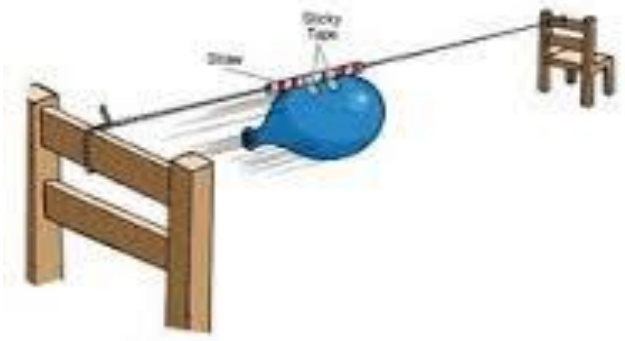
Draw a diagram and perform it: *You start standing close to the device. Hold 3 seconds. Walk 3 meters away from the device for 3 seconds. Hold for another 3 seconds, and then walk 2 meters away from the device for another 3 seconds.*

2. Motion encoder system for more precise experiments

Hands-on Activities for Newton's Three Laws

C. Third Law

1. Balloon Jet activities



<u>Project-based Approach:</u>

1. Design a team recipe about how to make a balloon move as far as possible (identify variables, procedures)
2. Measure an average speed in your experiment setting
3. Describe how speed would change during your experiment setting
   Limitation: move your balloon horizontally

2. Skating board activities (Prediction-Observation-Explanations)

- You **push** a wall
- You and your teammate **push each other**
- You **push** your teammate but she/he **doesn't push** you.
- You **pull** your teammate (with a rope) but she/he **does nothing**.

What is Newton's Mind/ Best for Newton's Laws

Two Big Picture Questions:

1. Why **THREE**?
   Is it a complete set of (hypothetical) theories / (empirical) laws that can describe **forces and motion on an object**?

2. $\Sigma F = 0$
   $\Sigma F \neq 0$
   F_{action} and $-F_{reaction}$

Should we start from scientific definitions or should we start from hands-on activities?

Implications of Newton's Third Law

For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law). (MS-PS2-1)

Let's think about a concept of LOVE.

Love is an art of loving and being loved.

Keyword: ?

Interaction!

Using Graphic Novels to Understand Science

- How is the use of text changing in the science classroom?

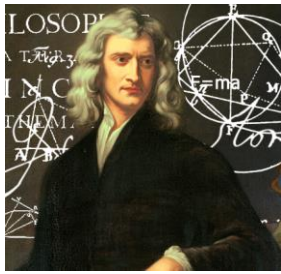
Why Graphic Novels?

EGMONT

- Globalization has led to an emergence of greater reliability on visual modes of communication.
- New technologies make interactive, nonlinear, and hypertextual forms of communication possible.
- Graphic novels increase motivation.
- Graphic novels may help students connect with content that they struggle comprehending from their textbook. (Hassett & Schieble, 2007; Jimenez & Meyer, 2016)

Graphic Novel:
A Crash Course in Forces and Motion with Max Axiom Super Scientist

Your Task in Small Groups



- 1) Read the pages of the graphic novel provided.
- 2) As a group, fill in the empty speech bubble with text that illustrates Newton's 1st Law.
- 3) Discuss why you choose the particular piece of text you inserted.
- 4) Compare your text to that of the original author's text.

Connecting graphic novels to writing and technology: Story Visualizer

Tasks that provide opportunities for students to use spatial skills to imagine, visualize, and create lead us towards multimodal and multidimensional literacy (Spellman, Jones, & Katsio-Loudis, 2014).

Wrap-Up

Concluding Video

Title:

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Questions and Comments

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