Grade 6, Science, Laws of Motion and Gravity

How can you beat the laws of motion?
The Egg Drop

Unit Developed by Michelle Anderson
Kimberly Middle School, Kimberly School District
Kimberly, Idaho

The Core Teacher Program
A program of the Idaho Coaching Network
Idaho Department of Education

An Idaho Core Teacher Program Unit Developed by Core Teacher: Michelle Anderson Unit Title: How can you defeat the laws of motion?

Universal Design for Learning (UDL)

Multiple Means of Representation Provide options for perception ❑ Offer ways of customizing the display of information ✓ Offer alternatives for auditory information ❑ Offer alternatives for auditory information	Provide options for language, mathematical expressions, and symbols ✓ Clarify vocabulary and symbols ❑ Clarify syntax and structure ❑ Support decoding text, mathematical notation, and symbols ✓ Promote understanding across languages ✓ Illustrate through multiple media	Provide options for comprehension ✓ Activate or supply background knowledge ❑ Highlight patterns, critical features, big ideas; and relationships ❑ Guide information processing, visualization and manipulation ✓ Maximize transfer and generalization
Multiple Means of Action and Expression Provide options for physical action ✓ Vary the methods for response and navigation ❑ Optimize access to tools and assistive technologies.	Provide options for expression and communication ❑ Use multiple media for communication ❑ Use multiple tools for construction and composition ✓ Build fluencies with graduated levels of support for practice and performance	Provide options for executive functions ❑ Guide appropriate goal-setting ✓ Support planning and strategy development ❑ Facilitate managing information and resources ❑ Enhance capacity for monitoring progress
Multiple Means of Engagement Provide options for recruiting interest ✓ Optimize	Provide options for sustaining effort and persistence ❑ Heighten salience	Provide options for self-regulation ✓ Promote expectations and beliefs that

individual choice and autonomy
✓ Optimize relevance, value, and authenticity
❑ Minimize threats and distractions

of goals and objectives
✓ Vary demands and resources to optimize challenge
✓ Foster collaboration and communication
❑ Increase mastery-oriented feedback

optimize motivation
❑ Facilitate personal coping skills and strategies
❑ Develop self-assessment and reflection

Webb's Depth of Knowledge - Level 1 (Recall)

❑ Who, What, When, Where, Why
❑ Define
✓ Identify
❑ Illustrate
❑ Label
✓ List
❑ Match
❑ Measure
✓ Recite
✓ Recognize
❑ Report
❑ Use

Webb's Depth of Knowledge - Level 2 (Skill/Concept)

❑ Categorize
❑ Classify
❑ Collect and Display
❑ Compare
✓ Construct
❑ Estimate
❑ Graph
❑ Identify Patterns
✓ Infer
❑ Interpret
❑ Observe
❑ Organize
✓ Predict
❑ Summarize

Original unit development sponsored by The Idaho Coaching Network

Webb's Depth of Knowledge - Level 3 (Strategic Thinking)

- ❑ Assess
- ✓ Construct
- ❑ Critique
- ✓ Develop a Logical Argument
- ❑ Differentiate
- ✓ Draw Conclusions
- ✓ Explain Phenomena in Terms of Concepts
- ❑ Formulate
- ✓ Hypothesize
- ❑ Investigate
- ✓ Revise
- ❑ Use Concepts to Solve Non-Routine Problems

Webb's Depth of Knowledge - Level 4 (Extended Thinking)

- ❑ Analyze
- ✓ Apply Concepts
- ❑ Connect
- ✓ Create
- ❑ Critique
- ✓ Design
- ❑ Prove
- ❑ Synthesize

Idaho Coaching Network Unit Plan Template

Unit Title: How can you defeat the laws of motion?

Created By: Michelle Anderson

Subject: Physical Science

Grade: 6

Estimated Length (days or weeks): 4 weeks (60 minute class periods 5 day weeks)

Unit Overview (including instructional context): Students will engage in various lab exercises that help illustrate Newton's laws of motion and gravity. They will use the results of their labs to help explain or justify the egg drop container design the students create. Students will refine their design throughout the instruction culminating in a series of test drops in the science classroom from a height less than the final drop.The final drop

will be from a height of about 2 stories with the students' goal for their egg to survive the fall without breaking. The unit is designed for 6th grade students in a rural school, about 30 students per class inclusive IEP, ELL and gifted students. The unit is taught at the end of the year during the fourth nine weeks after students have practiced both the engineering design process and the scientific method.

Unit Rationale (including Key Shift(s)):

Key Shift #2: Students will participate in reading/writing/speaking that is grounded in evidence from the text, across the curriculum.

The unit presents an opportunity for 6th grade science students to present what they know about Newton's Laws of Motion and why they understand their knowledge, not just make a hypothesis, but explain why the object in motion will be protected by the design based upon evidence collected from in-class activities and the science text. Students will have multiple opportunities to refine their egg drop design, utilizing the engineering process they have been taught in STEM class, in order to achieve the best results on final drop day.The activities including class discussion, modeling, and explaining Newton's Laws will provide students with knowledge to inform and refine their design because they may not be successful on attempt 1. The Egg Drop will provide authentic scientific purpose to practice persistence through revision and failure because there is more than one correct answer to this question.

Essential Question(s):	**Measurable Outcomes:**	
How do laws affect our lives? ● What can you do to beat the laws of motion? ● How can you use the laws of motion to protect yourself? **Enduring Understandings:** ● All objects follow the same laws of motion ● Information presented in a graphic form needs to be informative and yet maintain audience interest. "low effort high reward"	Learning Goals Success Criteria (Evidence): ● Students will use data and evidence from Newton's Laws and class experiments to help guide and explain the design of their egg drop container. ● Students will demonstrate understanding of the forces at work on a falling object by providing a drawing of their egg drop container showing the forces at work on the container and the materials used to counteract those forces. ● Students will present their poster and container results to the class with clear speech, maintaining good eye contact, appropriate volume and using scientific vocabulary. ● Student posters will be organized, neat and meet the rules of good evidence outlined in class including low effort high reward and using only 3-5 colors. ● Students will use appropriate elaboration techniques to explain their choice of materials used in the egg drop container.	
Targeted Standards:	**Targeted Standards:**	**Targeted Standards:**

Idaho English Language Arts/Literacy Standards:	Content Standards:	Standards for Mathematical Practice (if applicable):
● W.S.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. ● S.L.6-8.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details and examples; use appropriate eye contact, adequate volume, and clear pronunciation. ● R.S.6-8.7 Integrate quantitative or technical information in words in text with a version of that information expressed visually **Supporting Standards** ● R.S. 6-8.4 Determine the meaning of symbols, key terms, and other domain specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics ● W.S.6-8.2a. Informative text: Introduce a topic clearly, previewing what is to follow; organize ideas, concepts and information into broader categories as appropriate to achieving purpose; include formatting, graphics, and multimedia when useful to aiding comprehension..	● 6.S.1.6.4 Use evidence to analyze data in order to develop descriptions, explanations, predictions, and models. ● 6.S.2.2.1 Describe the effects of different forces (gravity and friction) on the movement, speed, and direction of an object.	

Summative Assessment:

- Summative Assessment Description: Students will apply and adapt what they have learned about the laws of motion by creating a prototype container that could be used to airdrop medicines in hard to reach areas with drones. Students will be required to choose materials from an

approved list and justify those choices with evidence gained from testing their prototype and in class experiences with Newton's Laws of motion. Students will be allowed to use Powerpoint, Prezi or a poster making software to present their egg drop project. See files attached for student instruction handout and rubric.

- Depth of Knowledge (DOK) Explanation: Demonstrating DOK level 3 and 4, students will use data and evidence from Newton's Laws and class experiments to help guide and explain the design of their egg drop container. Students will demonstrate understanding of the forces at work on a falling object by providing a drawing of their egg drop container showing the forces at work on the container and the materials used to counteract those forces. The building of an egg drop container with explanation demonstrates transfer of knowledge about the forces at work on a falling object and how to possibly beat them.

- Rubric or Assessment Guidelines:
  See documents attached including: Egg drop rubric https://drive.google.com/open?id=0B9crrumeQI2rMUpoR3RGY24wb0k,
  Student instructions https://drive.google.com/open?id=0B9crrumeQI2rS0RORzY2Z1RsNjQ
  Student daily work record https://drive.google.com/open?id=0B9crrumeQI2rQzFsc2pPS2M5YlE
  Student reflection https://drive.google.com/open?id=0B9crrumeQI2rWjZ1MjNzVHVPVVU
  Student poster examples https://drive.google.com/open?id=0B9crrumeQI2rRGxJN1lndUEwMWM

Primary Text(s):

- *Motion and Forces* textbook, Publisher: McDougal Littell Science, 2006

Supplemental materials/resources:

- Science World December 12, 2016 VOL. 73 NO. 6 Article Free Falling by Andrew Klein. A subscription required to view this article.
- http://scienceworld.scholastic.com/issues/12_12_16/book#/20
- Video: Bill Nye: Motion
- "Mythbusters: EGG Drop Competition". You Tube https://www.youtube.com/watch?v=ZOMW3hplSpI

Text Complexity Analysis:

Text Complexity Analysis of Title: *Motion and Forces* textbook Publisher: McDougal Littell Science, 2006
Text Type: Informational

Text Description	Recommended Complexity Band Level
McDougal Littell Science text, "Motion and Forces",	*What is your final recommendation based on quantitative, qualitative, and reader-task considerations? Why?* This text is recommended for middle level students in grades 6-8. The text structure is very complex due to

Chapter 2 explaining Newton's Laws of Motion. The structure of the text is hierarchical with simpler ideas building to more complex such as what is motion leads to unbalanced forces cause and change motion. The text will provide examples of Newton's three Laws of Motion in both written and graphic form, incorporating relatable real world examples such as soccer and basketball.	the organizational method. The more complex ideas could require pre teaching about the text, including how to use the features available within the text. The sentences are short and to the point with mostly conversational vocabulary. The science content, however, is more abstract and will require supplement in the form of additional examples and classroom activities to make these abstract ideas more concrete. *Mark all that apply:* Grade Level Band: K-5 ☐ **6-8 x** 9-12 ☐ PD ☐ Content Area: English/Language Arts (ELA) ☐ Foreign Language (FL) ☐ General (G) ☐ Health/Physical Education (HPE) ☐ History/Social Studies (HSS) ☐ Humanities (H) ☐ Math (M) ☐ Professional Development (PD) ☐ Professional/Technical Education (PTE) ☐ **Science (S) x**

Quantitative Measure

Quantitative Measure of the Text:	Range:	Associated Grade Band Level:
Lexile 1050	750-1180	Grade 6-8

Qualitative Measures

Text Structure : Very Complex

Informational text with graphics and examples. The book is arranged in chapter where the beginning information builds to the ideas explained or outlined in later sections of the text.

Language Clarity and Conventions : Moderately Complex

Sentences are short and to the point. The examples provided are meant to be relatable to middle school students. Sports are commonly used in the pictures along with spacecraft. Tier 2 vocabulary concerns include *exerts, equal and opposite, action, reaction.*

Levels of Meaning/Purpose: Slightly Complex

Direct instruction and explanation of Newton's Laws of Motion with words and images.

Knowledge Demands: Moderately complex

Subject Matter Knowledge: Relies on common, practical knowledge and some discipline-specific content knowledge; includes a mix of simple and more complicated, abstract ideas. Intertextuality: Few references or allusions to other texts or outside ideas, theories, etc.

Considerations for Reader and Task	
Possible Major Instructional Areas of Focus (include 3-4 CCS Standards) for this Text: ● R.S. 6-8.4 Determine the meaning of symbols, key terms, and other domain specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics. ● W.S.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. ● R.S.6-8.7 Integrate quantitative or technical information in words in text with a version of that information expressed visually Idaho Science Content Standards Grade 6 ● 6.S.2.2.1 Describe the effects of different forces (gravity and friction) on the movement, speed, and direction of an object.	Below are factors to consider with respect to the reader and task: Potential Challenges This Text Poses: The text structure could pose problems for students. I would review the meaning of headings and things to notice within the text structure such as the graphic used to explain each of the Laws of Motion. The vocabulary referenced within the chapter needs to be taught prior to this unit students will need to understand terms such as *mass, force, acceleration and velocity*. Differentiation/Supports for Students: ● ELL students can be supported with a Spanish language version of the text. ● The students will need a graphic organizer to help them separate out the 3 Laws of Motion and distinguish between them. ● A vocabulary review of terms previously covered such as *force, acceleration and mass* will be required. ● Students finding their own examples of Newton's Laws will allow for advanced students to stretch their understanding of the laws with more complex examples.

Students will use the text to learn the Laws of Motion. They will then use the models provided in the text to help them categorize other real world examples of Newton's Laws of Motion.	

Scaffolds and Extensions

UDL Components:	Support for students who are ELL, have disabilities or read well below grade level text band:	Extensions for advanced students:
Perception	• Spanish textbook • Audio text • Read aloud • Visual vocabulary • Rubrics • Checklist • daily journal of accomplishments • Station work - pacing • Guided notes and teacher copies • Models	• Choice of materials for build of container • Option of working alone • More advanced tech choices for display • Station allow some students to move faster through materials • Self assessment and peer review • Research other uses of this type of container

Vocabulary

Targeted Academic Vocabulary	**Targeted Content Area Vocabulary**
force, direction, net, unbalanced, gravity, contact, friction. remain, exerted, initial, original, mass, acted, upon, increase, decrease, times. applying, action, reaction, equal, opposite, predict, describe, limitations, law	velocity acceleration force gravity inertia mass Newton

Instructional Sequence

Major Idea/Topic #1 What are Newton's laws of motion?		
Day(s) and Desired Outcome(s)	Texts and Resources	Instructional Notes (including Scaffolding, Extensions, Vocabulary Terms and strategies, UDL Principles, and Formative Assessments)
Day(s) ➔ 1 to read and write laws in foldable. ➔ 3 additional days to add examples to	• Textbook Chapter on force and motion • Rubric • Drawing paper	**Build foldable**: name each law and provide a real world example with elaboration that justifies the choice See instructions and rubric attached https://drive.google.com/open?id=0B9crrumeQI2rWjFHU1V3N3RmWHM **Opportunity for enrichment**: Students may choose to create brochure including information about Newton using technology; see student example. https://drive.google.com/open?id=0B9crrumeQI2rNzJHZ2h5dWt0Y0k

foldable **Desired Outcome:** use real world examples to demonstrate understanding of the 3 Laws of Motion. Practice elaboration		Also allow students the freedom to use different designs to create their foldable. Most 6th graders are familiar with several types of foldables. Note: Students began foldable prior to Station Tasks by reading about and writing Newton's 3 Laws from the classroom or primary text referenced above. Students add examples to their foldable at the same time they complete the station labs.
Day(s): **2-4** total of 3 1 hour instructional periods. **Desired Outcome(s)**: Students learn their are 3 basic Laws of Motion.	• Station instructions and materials • Individual student handouts for note taking	Newton's Law Station Activities: each station explains one of Newton's Laws. There are 7 stations total. Students complete a handout as they rotate through each station. The stations will require students to work together in small groups to complete the activities; their discussions will include the use of vocabulary terms to deepen understanding. The stations benefit all levels of learners because the note taking utilizes different modes of engagement: some stations require drawing vocabulary terms and others require written explanations of which law is being demonstrated. Organizational note: I made two sets of the 7 stations and put students into small groups of 3 students to rotate through the stations with 12 minute rotations. Any time left after the station task was complete, students could use for working on examples and drawings for their Newton's Foldable. Formative Assessment: each day students complete an exit ticket (Muddy/ Marvy) about what they have learned that day. This will help the teacher monitor areas of extra concern. https://www.teacherspayteachers.com/Product/Newtons-Laws-of-Motion-Stations-Interactive-and-Fun-870645

Day(s): 5-7: total of 3 instructional periods including 1 for presentations **Desired Outcome:** Explain the Law of Motion to others using example activity Create a poster or handout to practice elaboration	• Station activity • Science expo day with younger students	In small group of 3, students design a poster to explain the activity connection to one of Newton's Law's using claim, evidence, and elaboration techniques. Groups may use an activity presented in class or design one of their own. Students will demonstrate understanding of a particular Law of Motion through their interactions with the younger participants. The vocabulary will be assessed by how students explain the targeted vocabulary to a younger audience.

Major Idea/Topic #2: How can we beat the Laws of Motion by breaking an egg?		
Day(s) and	Texts and	Instructional Notes (including Scaffolding, Extensions, Vocabulary Terms and strategies, UDL Principles,

Desired Outcome(s)	Resources	and Formative Assessments)
Day(s): 8-9 or 1 60 minute period: 2 periods to complete close reading activities with science world article **Desired Outcome(s)**: Build background knowledge about real world application of egg drop	• Drone video • Article about drones in Costa Rica *Science Scope* article: "Freefall Skydiving Without a Parachute", Dec 12,2016	http://www.ticotimes.net/2016/09/19/drones-costa-rica-medicine 1. Introduce project idea and its objective 2. Brainstorm materials http://scienceworld.scholastic.com/issues/12_12_16/book#/20 Close read of text identifying the specific methods that were used to create his safe jump and how those methods connect to Newton's Laws of Motion. **Preread questions:** I used the questions before and after reading. Vocabulary Web: connecting terms *drag, momentum, terminal velocity, gravity, tension,trajectory, air pistons, action, reaction, inertia* How do Skydivers survive jumping from a plane? What forces are acting on a skydiver? Do you think a skydiver could survive without a parachute? **During reading:** Summarize/ Paraphrase 3 techniques Luke Aikins used to survive his free fall? How do the techniques help Luke survive freefall? **After reading:** Vocabulary Web: connecting terms *drag, momentum, terminal velocity, gravity, tension,trajectory,* Gallery walk to review different groups vocabulary web, use post it notes to comment on webs or ask questions. **Formative assessment:** Teacher view webs to assess student understanding of vocabulary and review

		the connections are students forming. How could you replicate his methods in building your egg drop container?
Day(s) 10-12: 3 1 hour class periods **Desired Outcome(s):** Egg drop container with presentation explaining why	-Instructional handout -materials for building prototypes -Class notes and text for use in supporting design choices	1. Give time for student groups to plan, build, and test ideas without eggs 2. At end of class, use a few minutes to engage students in a discussion ● *What factors about a material should you consider in order for it to function properly?* ● *What is the function of the container that you are designing?* ● *How can the structure of the container allow it to function?* ● *How can the planned structure of your design be shown on paper?* ● *How can the intended function of your design be shown on paper?*
Day(s) 13: 1 hour class period **Desired Outcome(s):** Students will use knowledge, evidence to support their	-Gallery walk explaining design choice to classmates	● *How will the structure of your design allow it to function as a protective container?* ● *What will happen to the forces when the container makes contact with the floor?* ● *Link to student examples of poster presentation* *https://drive.google.com/open?id=0B9crrumeQI2rRGxJN1lndUEwMWM*

design		

Day(s) 14: 1 hour class period **Desired Outcome(s):** Students will witness their container dropped and answer analysis questions individually	<u>Drop Day</u> -Use football stadium bleachers to drop containers that meet size limits	*Analysis Questions: Individual students submit their own work.* ● *Address each prompt clearly using correct grammar, spelling, and mechanics.* ● *Support ideas with evidence from your observations and include reasoning that connects your ideas to scientific principles (Newton's Laws).* 1. *List all materials used in the structure of the container. How does each material in the structure contribute to the container's function to protect the contents?* 2. *What forces are acting on the container once the container is dropped?* 3. What happened to the forces as the container and egg fell and hit the floor? Support your answer with evidence. 4. When the container hit the floor, what happened to the forces acting on the container? Explain how your design's structure reduced the amount of force transferred to the egg. Be sure to review your diagram and revise the ideas based on what happened to the container when it fell.

Other (important elements not captured in this template, explanation, reflection supplementary materials):

A daily work record was given to students where they were required to document their plans for the day and what each member of the group was planning to accomplish. The students would then discuss if goals were met with a why or why not on the form each day to hand in with their final project. See the following link for work record https://drive.google.com/open?id=0B9crrumeQI2rQzFsc2pPS2M5YlE

I choose to have students build their containers and create their presentations at school in order to ensure that students were building the containers themselves with little help from parents. I emphasize using recycled materials with students, trying to prevent them from going out and buying materials to build a container. The guidelines for the egg drop competition could be changed from year to year based on results from previous years.