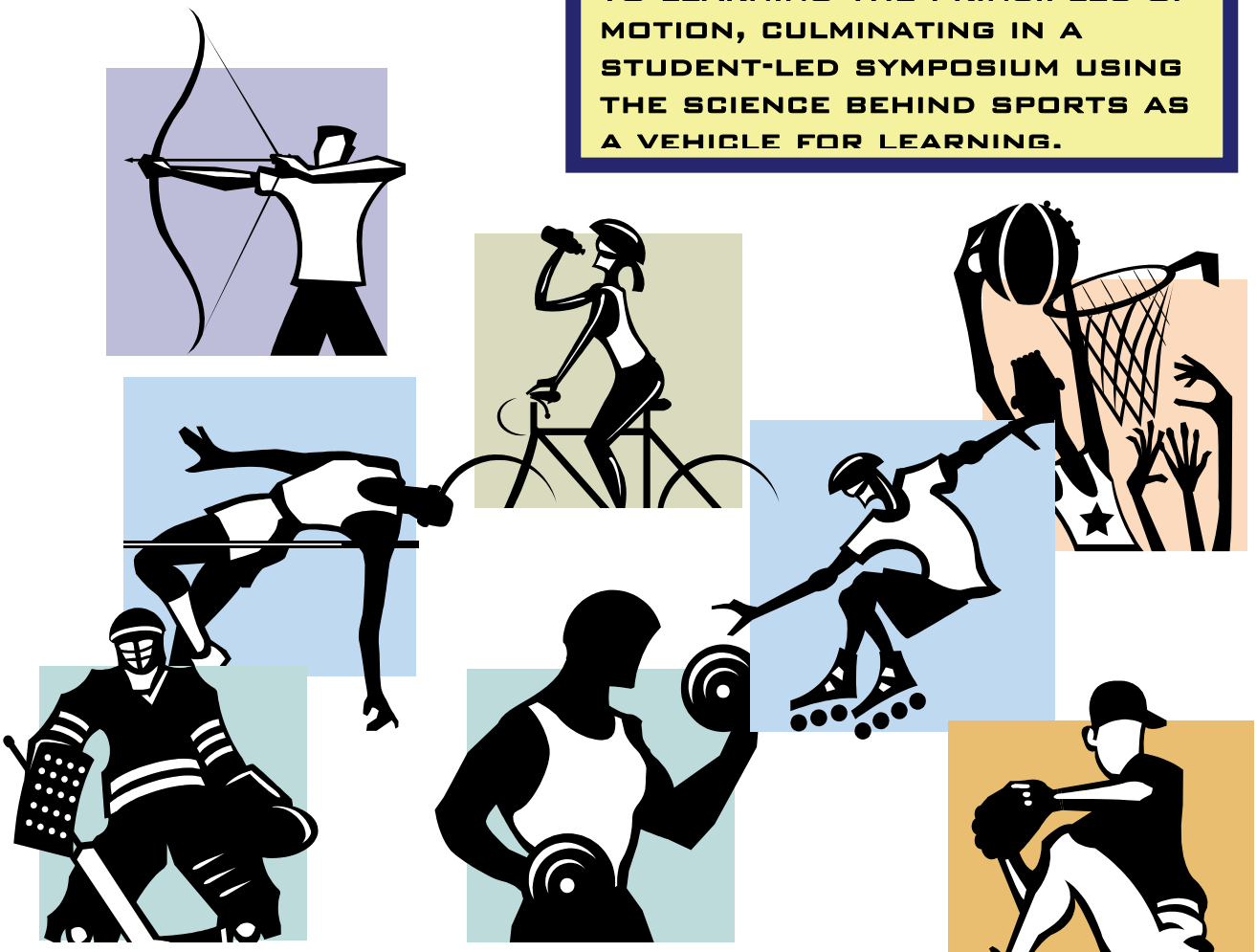
Force & Motion

A research-based approach to learning the principles of motion, culminating in a student-led symposium using the science behind sports as a vehicle for learning.



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OVAL 1: WHAT SHOULD STUDENTS KNOW AND BE ABLE TO DO?

CONTENT STANDARDS & ALIGNMENT

NYS Standards	WI Outcomes	Activities
Analysis, Inquiry & Design: Explanations: The central purpose of scientific inquiry is to develop explanations of natural phenomena in a continuing, creative process.	Employ mathematics in gathering and presenting data and analyzing risk/benefit.	* Calculating Speed & Acceleration (Class Experiments)
STANDARD 4: The Physical Setting		
4.1C Most activities in everyday life involve on form of energy being transformed into another. For example, the chemical energy in gasoline is transformed into mechanical energy in an automobile engine. Energy, in the form of heat, is almost always one of the products of energy transformations.	Design and conduct a demonstration to show how energy is transferred without being destroyed. Identify each type of energy.	Lab: Pulleys; Calculating Mechanical Advantage; Conservation of Energy
4.1e Energy can be considered to be kinetic energy, which is the energy of motion, or potential energy, which depends on position.	Compare and contrast energy of motion and stored energy	Potential and Kinetic Energy Demonstrations & Problems
5.1a The motion of an object is always judged with respect to some other object or point. The idea of absolute motion or rest is misleading.	** *Identify points of reference when describing motion.*	A Walk in the Park Lab
5.1b Its position, direction of motion and speed can describe the motion of an object.	Relate and describe the relationship between the amount of applied force and the overall direction of motion.	Physics of Car Crashes: Videotape & Discussion Table Hockey
5.1c An object's motion is the result of the combined effect of all forces acting on the object. A moving object that is not subjected to a force will continue to move at a constant speed in a straight line. An object at rest will remain at rest.	Design an experiment to test forces due to acceleration and create a graph to represent the motion. Design an experiment to demonstrate the effect of unbalanced forces on an object.	Acceleration Lab Moving Marbles
5.1d Force is directly related to an object's mass and acceleration. The greater the force, the greater the change in motion.	Describe the functions of machines in terms of work and power.	Work & Power Lab Simple Machines Labs
5.1e For every action there is an equal and opposite reaction.	** *Demonstrate Newton's third law.*	Newton's Laws Demonstrations
5.2a Every object exerts gravitational force on every other object. Gravitational force depends on how much mass the objects have, and how far apart they are. Gravity is one of the forces acting on orbiting objects and projectiles.	Relate and describe the relationship between the amount of applied force and the overall direction of motion. *(**As it relates to the force of gravity)*	Newton's Second Law Lab

NYS Standards	WI Outcomes	Activities
5.2c Machines transfer mechanical energy from one object to another.	...Analyze energy transformations. Design and conduct an experiment to show how energy is transferred without being destroyed.	Moving Marbles Table Hockey
5.2d Friction is a force that opposes motion.	***Compare and contrast helpful vs. harmful friction.*	Table Hockey
5.2e A machine can be made more efficient by reducing friction. Some common ways of reducing friction include lubricating or waxing surfaces.	Describe the functions of machines in terms of work and power.	Work and Power Lab Mechanical Advantage Lab w/ Pulleys Simple Machines Demos
5.2f Machines can change the direction or amount of force, or the distance or speed of force required to do work.	Describe the functions of machines in terms of work and power.	Work and Power Lab Mechanical Advantage Lab w/ Pulleys Simple Machines Demos
5.2g Simple machines include a lever, a pulley, a wheel and axle, and an inclined plane. A complex machine uses a combination of interacting simple machines, e.g., a bicycle.	Describe the functions of machines in terms of work and power.	Work and Power Lab Mechanical Advantage Lab w/ Pulleys Simple Machines Demos

** *"Anticipated" gap in outcome/state standards. WI outcomes were written using **national** MST standards, and **then** aligned with NY State.*

Essential Skills

Process Skills Based on NYS Standard 4

General Skills:

1. follow safety procedures in the classroom and laboratory
2. safely and accurately use the following measurement tools:
   - metric ruler
   - stopwatch
   - spring scale
3. Use appropriate units for measured or calculated values
4. recognize and analyze patterns and trends
5. identify cause and effect relationships

Physical Setting Skills:

1. Determine the speed and acceleration of a moving object

Key Concepts & Understandings

(ESSENTIAL TO KNOW)

After the completion of this unit, all students will have a deep understanding of Key Ideas 4 & 5. Students will be able to address the bullets under each Key Idea in a comprehensive manner.

4. Energy exists in many forms and when these forms change, energy is conserved.
   a. Describe the sources and identify the transformations of energy observed in everyday life.
   e. Describe the situations that support the principle of conservation of energy.

5. Energy and matter interact through forces that result in changes in motion.
   a. Describe different patterns of motion.
   b. Observe, describe and compare the effects of forces (gravity, electric current and magnetism) on the motion of objects.

Based on the MST Intermediate Level Science Curriculum Guide

OVAL 2: HOW WILL MY STUDENTS AND I KNOW WHEN THEY ARE SUCCESSFUL?

Evidence of Understanding

Performance Task/Project:
Science Behind Sports: This project involves the analysis of the underlying physics concepts behind a sport or leisure activity. Technical information on the sport will be collected through research, using both printed and electronic resources. After initial research is conducted, students will develop, conduct and analyze an original experiment based on a scientifically sound problem. Finally, research information and experimental results will be communicated throughout the grade level in a student-led symposium.

Homework: Homework usually serves one of three purposes: preparatory, reflective or practice. Depending on the purpose, homework will be either collected or reviewed with the class.

Quizzes:
1. Calculating Speed & Velocity
2. At Snail's Pace: A Quiz on Speed & Acceleration
3. Newton's Laws of Motion

Partner quizzes will be utilized with Quiz #2. Students benefit from working through the problems with someone else, and in effect "teach" one another they're thinking strategies. Another strategy that I employ with some quizzes is the Millionaire approach. Students are give three lifelines: Consult the text, 50/50 or Rephrase the question. Students have the chance to use the lifelines as needed throughout the quiz.

Tests:
As with all units or themes in the 7^{th} or 8^{th} grade level, culminating unit tests are formatted after the 4-part State format. Prior to testing, students are provided review materials (booklets, sessions, practice problems). Accommodations could include allowing students to prepare a "cheat sheet"

of notes, formulas or examples. In the past, students have been allowed to bring in one 3 x 5-index card with information to use while taking the test.

Self/Group Assessment:
As with any group project, it is helpful to hear candidly from students their perceptions about what they contributed to their group, and how their group members also contributed to the effort. After projects are completed, a group assessment guide is given out to team members. Large discrepancies in perceptions are addressed in a group meeting with me. Sometimes, the comments could be connected to point value or percentages of earned points, while at other times, these peer assessments are for informational purposes only.

Task Analysis

What students will <u>need to know</u> in order to complete task:

- Related vocabulary such as: motion, speed, acceleration, inertia, forces, gravity, centripetal force, centrifugal force, momentum, friction, work, power, kinetic energy, potential energy, conservation of energy, mechanical advantage
- Relationship between distance and time, velocity and time as it relates to determining course of motion
- Effect of gravity on all objects, especially falling objects
- Relationship between mass, velocity and momentum.
- Real-life examples of Newton's Three Laws of Motion
- Relationship between potential and kinetic energy and the conservation of energy
- What friction is, the by-product of friction and ways to increase or reduce it
- How machines make work easier by providing a mechanical advantage
- How energy is constantly converted from one form to another
- How to effectively conduct an independent experiment and data analysis

What students will need to be able to do in order to complete task:

- **Construct and interpret graphs** showing relationships between distance and time in regards to the motion of an object

- Construct and interpret graphs showing relationships between velocity and time in regards to the acceleration of an object
- Given the necessary variables, **calculate** speed, velocity, acceleration, force, work power and mechanical advantage
- Effectively **research** a selected sport
- **Sort** research to identify important information
- **Develop and conduct** a sound experiment involving performance ideals within their selected sport.
- **Organize** research information and experimental results into a meaningful and informational presentation
- **Defend** results of experiment and research findings

Collegial Connections

The implications for connections within this unit are immense. The team structure at Dake allows for collaboration between core subjects (math, science, social studies and English) as well as with a special educator assigned to the team. A teamwide "Quality Paragraph" rubric will be used to assess writing materials as part of the performance task.
Within the subject area, the three 8th grade science teachers will be involved with the unit and the performance task at the same time. The expectations, guidelines and learning experiences are common among the teams.

OVAL 3: WHAT LEARNING EXPERIENCES WILL FACILITATE THEIR SUCCESS?

EQUIPPING STUDENTS

Teaching and Learning Experiences that will Equip Students to Demonstrate Understanding

Standard Alignment:
Students in my classroom utilize an interactive notebook. Within this context, at the start of every unit, the standards for the unit are addressed, as well as the outcomes associated with that standard. Students maintain a copy of these standards within their spiral, and reflect on their progress in meeting the associated outcomes.

** Numbers do not correspond to length of lesson/activity, merely they describe the order of learning experiences.

1. Conduct Unit Anticipation Guide Activity (see attached)
2. Introduce Standards and Outcomes for the Unit
3. Begin Read Aloud: Rocket Boys; Use spiral to reflect on weekly sections
4. A Walk in the Park...Experiment to identify frames of reference, relationship between distance and time
5. Lesson on Speed and Velocity: Calculations & units
6. Interpreting Speed and Velocity Graphs
7. QUIZ 1: Speed and Velocity
8. Moving Marbles...Experiment to determine how acceleration changes as an object travels down a ramp
9. Lesson on Acceleration: calculations and units
10. Interpreting Acceleration Graphs
11. Gravitational Force
12. Acceleration Lab...determining the acceleration due to gravity on falling objects
13. Re-enforcing calculations of acceleration, speed and velocity** Differentiated cubes
14. At Snail's Pace **Partner Quiz
15. Introduce Science of Sports Performance Assessment
16. Students select groups and sport for focus
17. Students develop a timeline of activities and "contract" for completion
18. Lesson on Forces: friction, momentum, centripetal, centrifugal

19. Table Hockey Activity
20. Balanced vs. unbalanced forces
21. Lesson: Newton's Laws of Motion
22. Newton's Second Law Lab: Force = Mass x Acceleration
23. Quiz: Newton's Laws of Motion: Open spiral
24. Watch "Physics of Car Crashes" and complete reflection activity
25. Lesson on: Conservation of energy as it relates to motion
26. Students conduct research for performance assessment
27. Lesson: calculating mechanical advantage
28. Using Pulleys for Mechanical Advantage Lab
29. Review Materials Provided in-class for unit test
30. Rocket Boys Read-aloud completed; Reflection completed in spirals
31. Re-group performance assessment; experimental design
32. Conduct performance-based experiments; generate reports
33. Unit Test: Force & Motion
34. Performance Assessment Wrap-up
35. Performance Assessment Student Symposium: "The Science of Selected Sports..."

Differentiation & Accomodations

A. Grouping Strategies

- Direct instruction can be accomplished using 10:2 format, with a partner available to Think-Pair-Reflect/Share
- Lab Activities are usually done in a small group (3-4 students/group). Groups may be student selected or teacher selected, depending on the level of difficulty or cooperation needed.
- For research groups, students will have some input as to one other person in their group. The remainder of the group will be selected based on heterogeneous grouping strategies.
- Question/answer cards, word/definition cards or concept/diagram cards can quickly accomplish Pairings. For this unit especially, there are multiple opportunities to work with partners.

B. Vocabulary/Reading Strategies

- Vocabulary terms are addressed using the Frayer model. Students with a wide variety of learning styles can then assimilate the word. By using this model, the definition is looked up, written, re-

formulated and a drawing is created by the student to simulate the word or concept. A "sign" for that word can also be created, to incorporate the kinesthetic learning style.

- Active reading strategies, including symbol-creation, highlighting, and about-point can be used to increase the comprehension of all students.
  - Symbol creation allows students to react to what they have read using a student-generated symbol scheme. For instance, if they have a question about what they read in the first paragraph, they mark a ? on a sticky note or "book-mark" that correlates to the paragraphs on the page. Other symbols can be used to show understanding, ideas, confusion, ease, etc...
  - Highlighting is a strategy that all students need to be taught. It can be especially helpful for the student who is artistic in style, as the color can reinforce memory.
  - About point is a large or small group strategy, where, after students read a selected sentence or passage, they complete the phrase: That passage was about.....and the author's point for writing it was....." The strategy can be modified to include examples, etc...

C. Reflection Strategies

- Within their interactive notebooks, students are given the opportunity to reflect on the work that they have accomplished in class. I am still in the process of developing the notebooks, but I think that a powerful tool to use as a study-guide should be the notebook, where students can go through their work and re-write key concepts or phrases on the margin, color-code or draw other relevant points, or create some other way to "reflect" on what they have accomplished. Using the spiral also provides an excellent way to frame the learning each day, as students can respond to demonstrations, prompts or diagrams in their spirals as a warm-up.

D. Test-taking Strategies

- Quizzes, modeled after the state assessments, can be differentiated as needed. Partner-based quizzes, choice of question or response format, and helper sheets are all tools to use when measuring the students' path to the standards.
- Students may take quiz assessments at different levels (A or B), or with the ability to make up their performance, if it falls below what they had hoped to achieve.

- Tests are modeled after the state assessment in format and questioning style.

E. Performance Task Differentiation Capabilities

- Students are provided choice in partner (at least one group member)
- Students are provided choice in selection of sport
- Students are provided choice in level of attainment
- Students are provided choice in reporting format
- Students are provided with a varying amount of research support & reporting framework.

Force & Motion

The Science Behind Sports

Student Packet

Welcome Sports Fans! This is your opportunity to learn all of the "tricks of the trade" about your favorite sport! You and a group will

1. Investigate a selected sport (from an extended list)
2. Relate it to Newton's Three Laws of Motion and other motion concepts
3. Choose a way to publish information
4. Publish It!
5. Set-up Display
6. Finally, present your findings in a school-wide sport symposium!

Feeling a bit overwhelmed? Here is a handy calendar to keep you on task!

Monday	Tuesday	Wednesday	Thursday	Friday
1. Project Intro. 2. Teams Form 3. Topic choices submitted	1. Bibliographies reviewed 2. Topics distributed	In-class research (Library)	In-class research (Computer Lab)	Week 1 Group Summaries Due
1. Select Presentation choice 2. Begin Rough draft & assign roles	1. Continue to fill in information, 2. Design presentation materials	In-class research (Library)	In-class research (Computer Lab)	Week 2 Group Summaries Due

Step 1: Choosing your Partner....

On the slip of paper provided, write the names of two possible partners for this investigation. In order for your choice to be valid, your name must also appear on their paper! Groupings will be based on your input!

Write the name of your FINAL group members here:

_____

_____

_____

_____

Step 2: Choosing your Sport...

From the list provided, rank your top five choices. When asked, supply that information to the whole group. Your final choice will come from those five.

List your top five choices here:

_____

_____

_____

_____

Circle the one that your group receives.

Step 3: Researching....

You and your group are on a quest. You are to find as much information as possible about the mechanics of your selected sport. Each group is to keep a running log of the day's events, as well as a check on the types of information found. To guide you on this quest, here are some questions you should be able to answer as a result of your research. Space after the question has been left for you to record bibliography information. Keep your notes on the note cards as discussed in class. By the way, this list is only a framework! Try to exceed these questions as you explore your interest in the sport.

1. What types of motion does the sport involve? (Circular path, straight line, etc.)	**2. What is the role of air resistance or friction in this sport? How are they used? How are they dealt with or reduced?**
3. How is momentum used/dealt with in this sport?	**4. Identify how Newton's first law relates to the sport. (Objects at rest...)**
5. Identify how Newton's second law relates to the sport (Force = mass x acceleration)	**6. Identify how Newton's third law relates to the sport (Every action...)**
7. What types of equipment are used in this sport?	**8. Are there any connections between physics principles and the equipment used? (Like, why do golf balls have dimples?)**
9. What speeds are reached in this sport? Acceleration intervals?	**10. How is technology used to enhance the sport?**

11. What are the energy conversions in this sport?	**12. How is energy conserved in this sport?**
13. Other	**14. Other**
15. Other	**16. Other**

Step 4. Putting It All Together

A. From your research, it will be up to your group to design a show-board, highlighting your findings regarding the 12 questions, as well as any other important information that you may find. The showboard will be shared with class members during the symposium.

B. <u>In addition</u> to the show-board, your group will need to publish your information in one of three ways:

1. Create a webpage, outlining information and containing links to sport-related web-sites.
OR
2. Create a PowerPoint presentation, outlining information in a unique and creative way
OR
3. Create a Picture-Book about the Physics of the sport, including illustrations!

The publications will serve to teach a larger audience about the science behind certain sports. These publications and presentations will be made available to future classes at Dake for research purposes.

Regardless of the choice you make<u>, all publications must:</u>

- **Be completed in a professional manner (spelling, grammar, etc...)**
- **<u>Clearly</u> show the science behind the sport: How do Newton's Laws apply?, What types of forces effect the player?, etc...**
- **Discuss/model the energy transfers involved within that sport.**

Literature Research Rubric

Attributes	Above Standard	Standard	Still A Goal	Points Earned
Research Synthesis	**10-9** Make meaning of the information researched by generating original example calculations, illustrations or graphs for use in presentation	**8.5-7** Make partial meaning of information researched, try to generate original examples.	**6.5-0** Students make little or no meaning of the information researched and cannot use as a tool to develop original examples.	**/10**
Depth of Research	**10-9** Information includes basics as well as an in-depth study of the sport	**8.5-7** Information includes the basics and an in-depth study has begun	**6.5-0** Information is incomplete and does not include basic information	**/10**
Diagrams	**10-9** At least 3 diagrams are included that increase the understanding of the scientific concept	**8.5-7** 2 diagrams are included that increase the understanding of the scientific concept	**6.5-0** Diagrams are missing or do not aid in the understanding of the concept	**/10**
Bibliography	**10-9** An accurate and extensive bibliography has been developed which includes: at least 2 electronic sources, 2 books and 1 magazine	**8.5-7** An accurate and extensive bibliography has been developed which includes: at least 1 electronic source, and 2 books.	**6.5-0** Bibliography is incomplete, sources are not referenced or bibliography is missing.	**/10**

Total: /40

Sympiosium Rubric

Attributes	Above Standard	Standard	Still A Goal	Points Earned
Relationship to Science Concepts	**10-9** Information presented clearly shows relationships of: motion, force, acceleration, etc..Players and equipment are addressed.	**8.5-7** Information shows relationships of motion, force etc..but may not cover all aspects of the sport or the concept.	**6.5-0** Information shows little relationship to science concepts. Aspects of sport are not completely addressed.	**/10**
Quality of Information	**10-9** Information shown in a professional manner, easy to read and understand.	**8.5-7** Information shown in a professional manner, may not be easily understood.	**6.5-0** Presentation is unprofessional and is not easily understood.	**/10**
Visuals & Supplementary Materials	**10-9** Oral reports include at least 3 computer-generated or handmade visuals. Visuals & supplementals add understanding of presentation.	**8.5-7** Oral reports include at least 2 computer-generated or handmade visuals. Visuals & supplementals may/may not add to the understanding of report.	**6.5-0** Oral reports did not include computer-generated or handmade visuals.	**/10**
Presentation	**10-9** Group members provide a clear, concise description of sport and relevant connections. Questions are handled in a relevant manner. All members participate	**8.5-7** Group members may provide a clear, concise presentation, but relevant connections are weak or lacking. Not all members participate.	**6.5-0** Group presentation is uninformative. Not all members participate.	**/10**

Total: **/40**

Student Observation Criteria

Your group's effort, cooperation, teamwork and communication will be observed and rated by your teacher on a daily basis. These informal observations will be the basis of your student observation grade. This aspect of your project will be 30/200 points. The criteria are as follows:

Use of Class Time	Came to class prepared and equipped. Made effective use of time. Were on task and actively involved in the project.
Team Work	Work together as a well-coordinated team. Divide large tasks into smaller pieces for all to contribute. Team members pulled their own share.
Communication/ Leadership:	Project leader was assigned, other roles also assigned: technology expert, materials manager, and science expert. Group used high levels of communication with one another and teacher throughout the project.

Publication Criteria

Web Pages:

- Have at least 3 links to other sites regarding sports
- Be at least 2 web-pages long
- Summarize your findings and scientific connections
- Contain at least 2 diagrams, clip-art, data table, or other visual
- Be creative, neat, and ready to up-load to the Dake Website.

Picture Books:

- Are at least 10 content pages in length
- Include title page, dedication, and cover
- Contain findings and scientific information
- Contain at least 5 diagrams, clip-art, data tables, or other visuals.

PowerPoint Presentations:

- Are at least 10 slides in length
- Contain findings and scientific connections
- Contain at least 2 diagrams, clip-art, data tables, or other visuals.
- Contain one video clip with sound bites.
- Be creative, neat, and ready to upload onto the Dake Website.