Bridgeport Public Schools

Embedded Performance Task

Grade 8

Shipping and Sliding

Teacher Manual

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OVERVIEW OF THE ELEMENTARY AND MIDDLE SCHOOL CURRICULUM-EMBEDDED PERFORMANCE TASK MODEL

The Connecticut State Board of Education approved the Core Science Curriculum Framework in October of 2004. The framework promotes a balanced approach to PK-12 science education that develops student understanding of science content and investigative processes.

WHAT IS A CURRICULUM-EMBEDDED PERFORMANCE TASK?

Curriculum-embedded performance tasks are examples of teaching and learning activities that engage students in using inquiry process skills to deepen their understanding of concepts described in the science framework. Developed by teachers working with the Connecticut State Department of Education, the performance tasks are intended to influence a constructivist approach to teaching and learning science throughout the school year. They will also provide a context for CMT questions assessing students' ability to do scientific inquiry.

The three elementary performance tasks are conceptually related to Content Standards in Grades 3 to 5 and the three middle school performance tasks are related to Content Standards in Grades 6 to 8. The elementary performance tasks provide opportunities for students to use the Inquiry Expected Performances for Grades 3 to 5 (see Science Framework B.INQ 1-10 skills) to understand science concepts. The middle school performance tasks provide opportunities for students to use the Inquiry Expected Performances for Grades 6 to 8 (see Science Framework C.INQ 1-10 skills) to understand science concepts.

Teachers are encouraged to use the state-developed curriculum-embedded performance tasks in conjunction with numerous other learning activities that incorporate similar inquiry process skills to deepen understanding of science concepts. Students who regularly practice and receive feedback on problem-solving and critical thinking skills will steadily gain proficiency.

HOW ARE THE PERFORMANCE TASKS STRUCTURED?

Each performance task includes two investigations; one that provides some structure and direction for students, and a second that allows students more opportunity to operate independently. The goal is to gradually increase students' independent questioning, planning and data analysis skills. The elementary performance tasks introduce students to understanding and conducting "fair tests". The middle school performance tasks focus on designing investigations that test cause/effect relationships by manipulating variables.

Mathematics provides a useful "language" for quantifying scientific observations, displaying data and analyzing findings. Each curriculum-embedded performance task offers opportunities for students to apply mathematics processes such as measuring, weighing, averaging or graphing, to answer scientific questions.

Not all science knowledge can be derived from the performance of a hands-on task. Therefore, each curriculum-embedded task gives students opportunities to expand their understanding of concepts through reading, writing, speaking and listening components. These elements foster student collaboration, classroom discourse, and the establishment of a science learning community.

A useful structure for inquiry-based learning units follows a **LEARNING CYCLE** model. One such model, the “5-E Model”, engages students in experiences that allow them to observe, question and make tentative explanations before formal instruction and terminology is introduced. Generally, there are five stages in an inquiry learning unit:

- **Engagement:** stimulate students’ interest, curiosity and preconceptions;
- **Exploration**: first-hand experiences with concepts without direct instruction;
- **Explanation:** students’ explanations followed by introduction of formal terms and clarifications;
- **Elaboration:** applying knowledge to solve a problem. Students frequently develop and complete their own well-designed investigations;
- **Evaluation:** students and teachers reflect on change in conceptual understanding and identify ideas still “under development”.

The performance tasks follow the “5-E” learning cycle described above. However, the teacher can decide the role the performance task will play within the larger context of the entire learning unit. Early in a learning unit, the performance task can be used for engagement and exploration; later in a learning unit, the performance task might be used as a formative assessment of specific skills.

HOW ARE PERFORMANCE TASKS USED WITH YOUR CLASS?

Curriculum-embedded performance tasks are designed to be used as part of a learning unit related to a Framework Content Standard. For example, while teaching a unit about human body systems (Content Standard 7.2,) the teacher decides the appropriate time to incorporate the “Feel The Beat” performance task to investigate factors affecting pulse rate. In this way, the natural flow of the planned curriculum is not disrupted by the sudden introduction of an activity sequence unrelated to what students are studying.

The performance tasks are NOT intended to be administered as summative tests. Students are not expected to be able to complete all components of the tasks independently. Teachers play an important role in providing guidance and feedback as students work toward a greater level of independence. Performance tasks provide many opportunities for “teachable moments” during which teachers can provide lessons on the skills necessary for students to proceed independently.

There is no single “correct” answer for any of the performance tasks. Students’ conclusions, however, should be logical, or “valid” interpretations of data collected in a systematic, or “reliable” way. Variations in students’ procedures, data and conclusions provide opportunities for fruitful class discussions about designing “fair tests” and controlling variables. In the scientific community, scientists present their methods, findings and conclusions to their peers for critical review. Similarly, in the science classroom, students’ critical thinking skills are developed when they participate in a learning community in which students critique their own work and the work of their peers.

Performance tasks should be *differentiated* to accommodate students' learning needs and prior experiences. The main goal is to give all students opportunities to become curious, pose questions, collect and analyze data, and communicate conclusions. For different learners, these same actions will require different levels of "scaffolding" as they move toward greater levels of independence. For example, if students have had experiences creating their own data tables, the teacher may decide to delete part or all of the data table included in the performance task. Other possible adjustments include (but are not limited to):

- Text readability;
- Allowing students to control all or some of the variables;
- Whether the experimental procedure is provided or student-created;
- Graph labels and scales provided or student-created;
- Expectations for communication of results; or
- Opportunities for student-initiated follow-up investigations.

There are many science investigations that are currently used in schools that provide inquiry learning opportunities similar to those illustrated in the performance tasks. Students need a variety of classroom experiences to deepen their understanding of a science concept and to become proficient in using scientific processes, analysis and communication. **Teachers are encouraged to use the state-developed curriculum-embedded performance tasks in conjunction with numerous other learning activities that incorporate similar inquiry processes and critical thinking skills.**

HOW ARE THE PERFORMANCE TASKS RELATED TO THE CMT?

The new Science CMT for Grades 5 and 8 will assess students' understanding of inquiry and the nature of science through questions framed within the CONTEXT of the curriculum-embedded performance tasks. Students are not expected to recall the SPECIFIC DETAILS OR THE "RIGHT" ANSWER to any performance task. The questions, similar to the examples shown below, will assess students' general understandings of scientific observations, investigable questions, designing "fair tests", making evidence-based conclusions and judging experimental quality.

Here is an example of the type of multiple-choice question that might appear on the Grade 5 Science CMT. The question is related to the "Soggy Paper" performance task:

> Some students did an experiment to find out which type of paper holds the most water. They followed these steps:
>
> 1. Fill a container with 25 milliliters of water.
> 2. Dip pieces of paper towel into the water until all the water is absorbed.
> 3. Count how many pieces of paper towel were used to absorb all the water.
> 4. Repeat with tissues and napkins.
>
> If another group of students wanted to repeat this experiment, which information would be most important for them to know?
>
> a. The size of the water container
> b. The size of the paper pieces *
> c. When the experiment was done
> d. How many students were in the group

Here is an example of the type of constructed-response question that might appear on the Grade 8 Science CMT. The question is related to the "Feel The Beat" performance task:

> Imagine that you want to do a pulse rate experiment to enter in the school science fair. You've decided to investigate whether listening to different kinds of music affects people's pulse rate.
>
> Write a step-by-step procedure you could use to collect reliable data related to your question. Include enough detail so that someone else could conduct the same experiment and get similar results.

NOTE THAT THE CMT QUESTIONS DO NOT ASSESS A CORRECT "OUTCOME" OF A PERFORMANCE TASK OR STUDENTS' RECOLLECTION OF THE DETAILS OF THE PERFORMANCE TASK. Students who have had numerous opportunities to make observations, design experiments, collect data and form evidence-based conclusions are likely to be able to answer the task-related CMT questions correctly, even if they have not done the state-developed performance tasks. However, familiarity with the context referred to in the test question may make it easier for students to answer the question correctly.

INTRODUCTION TO "SLIPPING AND SLIDING"

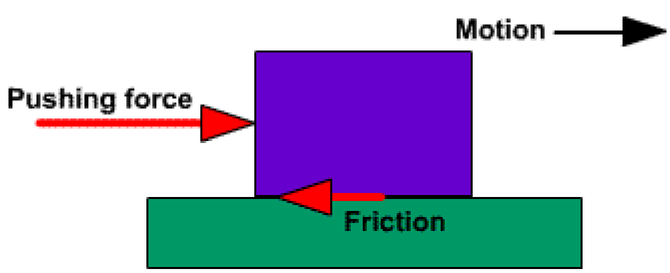
In this performance task, students will explore variables that affect the friction between two surfaces. First, they will conduct a guided inquiry to find out how the properties of surface materials affect friction. Then they will design their own experiment to explore an independent variable that they choose.

SAFETY NOTES:

- Review expectations for appropriate behavior, handling of materials and cooperative group procedures prior to beginning this investigation.
- For more comprehensive information on science safety, consult the following guidelines from the American Chemical Society - http://membership.acs.org/c/ccs/pubs/K-6_art_2.pdf and the Council of State Science Supervisors - http://www.csss-science.org/downloads/scisaf_cal.pdf

BACKGROUND:

Friction is a force that resists motion. It is present whenever two surfaces slide against each other. Although surfaces might look smooth, viewed under a microscope they are actually rough and jagged. When the surfaces are pushed or pulled against each other, their tiny jagged points get caught, making movement difficult.



The physical properties of different surfaces affect the amount of friction that results when they contact each other. The greater the friction force between the two surfaces, the greater the force needed to cause motion.

FRAMEWORK CONTENT STANDARD: Shipping and Sliding is related conceptually to the following learning unit:

8.1 - An object's inertia causes it to continue moving the way it is moving unless it is acted upon by a force to change its motion.

UNDERLYING SCIENCE CONCEPTS (KEY IDEAS):

- Friction is a force that resists motion and is present whenever two surfaces are in contact with each other.
- The amount of friction can vary depending upon the properties of the two surfaces in contact and the amount of force between the two objects.

KEY INQUIRY SKILLS:

- Pose investigable questions based on observations
- Identify dependent and independent variables and constants
- Present data in an organized format
- Interpret data to form conclusions
- Apply experimental results to solve problems

MATERIALS NEEDED: Listed below are all the materials needed to complete the two experiments in Shipping and Sliding. Some materials are supplied in starter kits provided by the Connecticut State Department of Education. These materials are marked with an asterisk (*). The remaining materials are supplied by the school district:

20 small washers	2 plastic cups to hold washers
20 large washers (or 25g, 50g, 100g, 200g weights)	Ruler
1 wooden block (approx. 10cm x 6cm x 3cm) *	Masking tape
1 Masonite test surface *	String (1 m)
2 or 3 jumbo paper clips	Access to a balance or scale
A plastic cylinder (a pen, for example)	Graph paper
	Various surface materials for testing

- If these materials are not available, substitutions can be made. The plastic cylinder can be replaced with a smooth wooden dowel and the wood block can be replaced with any rectangular object (e.g., a Jell-O box, package of index cards, etc.)
- Note: students might need more than 20 small washers for certain trials depending on variables altered.

ADVANCE PREPARATION FOR THE TEACHER:

1. Carefully read through all teacher and student materials. Modify the Student Materials based on the needs of your students. Then print and photocopy Student Materials.

2. Read the ENGAGE scenario aloud with students several days before beginning the actual experiments. Ask students to bring in samples of different surface materials whose friction properties they are interested in testing.
3. Gather all materials prior to the first day to ensure an orderly and efficient distribution. Suggestions include a “cafeteria line” in which supplies are laid out on the counter and students proceed through to take necessary amounts or a “packaged set” approach where appropriate supplies are already organized in separate containers and students obtain one container per group.
4. Determine laboratory groups to ease confusion at the introduction to the experiment.

ESTIMATED COMPLETION TIME AND PACING SUGGESTIONS:

Timing varies depending on the length of the class period. The **minimum** suggested classroom time is 110 minutes with some activities, such as the graph and the conclusions, completed at home. Listed below are two possible options that may be used for pacing:

- Option 1 (40-45 minute periods)

  Day 1: Teacher introduction of first task and lab partner discussion of experimental design. (this can be completed for HW) Students should complete up through step five before the next class period.

  Day 2: Teacher approval of design and performance of first task. Students will complete this at varying time lengths and should work on completing steps seven through eleven. If not complete, this should be finished for HW.

  Day 3: Teacher introduction of second task and group discussion of experimental design. Due to familiarity with the procedure, this will require less time and after teacher approval, students may begin the second task.

  Day 4: If necessary, students should finish the second task. Remaining time should be used for group discussion and completion of calculations and questions.

- Option 2 (90 minute periods)

  Day 1: Teacher introduction of first task and development of experimental design. This is followed by teacher approval of design and performance of task. Students will complete this at varying time lengths and should work on completing steps seven through eleven to be finished for HW.

  Day 2: Teacher introduction of second task and group discussion of experimental design. Due to familiarity with the procedure, this will be accomplished with less time and after teacher approval, students may begin the second task. Remaining time should be used for group discussion and completion of calculations and questions.

PEDAGOGY: Consult the teacher notes accompanying each step of the performance task for suggestions related to classroom implementation, differentiation, assessment and extension strategies. The ▲ symbol is used to indicate a differentiation opportunity. Each Teacher Note is followed by a reference to the Framework inquiry skill featured in that task component. For example, the notation “**C INQ.3**” indicates an inquiry skill related to designing or conducting a simple investigation.

Shipping and Sliding

A Guided Exploration of Factors Affecting Friction

ENGAGE

Many of the products we use are made or grown in other countries and sent here by plane, boat or truck. Some companies that make televisions, for example, put them in wood boxes that are carried here by cargo ships. When ocean waves cause the ship to tilt from side to side, the boxes sometimes slide across the cargo room floor and damage the televisions packed inside. Increasing the friction in the cargo room may solve the problem. The television manufacturer is willing to change the box materials and the shipping company is willing to change the floor materials. Imagine that you have been hired to conduct a friction study that will explore ways to increase the friction force and solve the problem of the sliding boxes.

Teacher notes:
Prompts can include:

- *"How can we cause the boxes not to slide?"*
- *Connection of friction with icy road conditions*
- *Discussion of friction with various shoe surfaces*
- *When is friction considered a "bad thing" vs. a "good thing?"*
- *How did friction help you get to school?*
- *Connection with sports – ex/ wax on skis, sneakers*

A quick demonstration of friction could be having the students quickly rub their hands together with varying speed and amounts of pressure.

EXPLORE

First, you and your partners will design and conduct experiments to find how friction is affected by different box and floor materials. Next, you will identify and explore another variable that may also affect friction. Then, you will analyze your experimental findings to make recommendations to the television manufacturer or the shipping company.

Get Ready

The first question you will explore in this investigation is the friction force created when different surface materials slide against each other. Gather a variety of different textured materials from home or school that you can test by attaching them to a model shipping box or cargo room floor. You may choose to experiment with **floor** materials (such as felt, carpet, sandpaper or tiles), or you may choose to test different **box** materials such as plastic, metal, wood or different papers.

Teacher notes:
Discuss possible materials for simulating different floor surfaces.

Bring these materials to class the day before you begin your friction experiments.

Teacher notes: As a back-up, provide a variety of materials for testing. Simulated floor surfaces can include samples of felt, tile, carpet, wood, and foil. For students who are varying the box materials, provide a variety of materials that shipping containers could be made from.

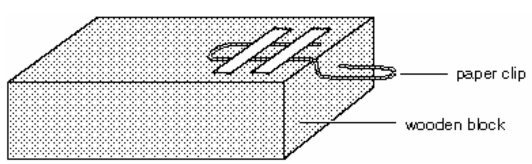
In addition to your own collection of textured materials, your teacher will provide your group with the following supplies:

20 small washers	2 plastic cups to hold washers
20 large washers (or 25g, 50g, 100g, 200g weights)	Ruler
1 wooden block (approx. 10cm x 6cm x 3cm) *	Masking tape
1 Masonite test surface *	String (1 m)
2 or 3 jumbo paper clips	Access to a balance or scale
A plastic cylinder (a pen, for example)	Graph paper
	Various surface materials for testing

Experiment #1: Effect of Materials on Friction Force
In this investigation, you will explore which combinations of floor and box materials create more or less friction. A simple way to measure friction is described below:

A Method for Testing Friction:
Teacher notes: You may find it helpful to demonstrate steps 1-5 as they are discussed.

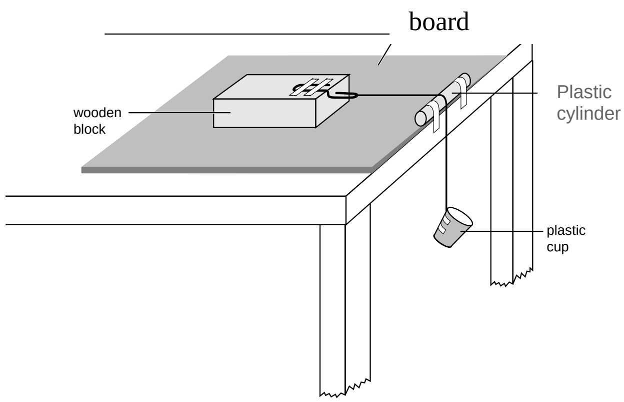
1. Construct a model shipping box like the one in the diagram below. The paper clip will allow you to pull the box with a measured amount of force:



2. Use a piece of cardboard as a model of a cargo room floor.

3. Tape a plastic cylinder along the edge of your work table. Place the cardboard shipping floor on your work table near the plastic cylinder.

4. Tie a loop at one end of the string and attach the loop to the paper clip. Drape the string over the plastic cylinder and use tape to attach the plastic cup to the other end of the string (see diagram below).



5. By adding small washers to the plastic cup, you can measure the pulling force needed to start the box moving. The more force needed to start the box moving, the greater the friction between the floor and the box materials. You can keep track of the number of washers, or you can find the mass of a single washer and keep track of the total mass needed to start the box moving.

Conduct Your Experiment

1. Identify the **question** you will investigate.

Teacher notes: Students may choose to keep the floor material constant and explore the friction created by changing the box materials, or they may keep the box material constant and vary the floor materials.   Students should be sure to include both an independent and dependent variable. **C INQ.1**

2. **Predict**, based on your experiences, which materials will have the greatest and least amount of friction.

Teacher notes: **C INQ.1**

3. Design a **procedure** to collect data to answer your research question. Identify the **independent** and **dependent** variables in your experiment. Think about the parts of your experiment that should be kept **constant** so you can collect consistent data.

Teacher notes: Students should be made aware that they need to quantify the amount of motion necessary. For example, they can require the block to move 10 cm. each time or if they state the block will hit the cylinder, they need to give the starting measurement of the block. This will *allow the variable of movement to remain constant. In addition, multiple trials are necessary to increase validity of results. Remind students that their design should include enough detail so that it can be easily replicated.* **C INQ.3**

4. Write your procedure in your science notebook. Include enough detail so that you or someone else could repeat your experiment.

Teacher notes: **C INQ.3**

5. Create a **data table** to record data related to your experiment.

Teacher notes: ▲ *Depending on your students' experiences creating their own data tables, you may want to provide them with a blank table without any labels, or you might provide some of the column and row labels.* **C INQ.5**

6. Do your experiment and **record** your findings in your data table.

Teacher notes: Students should be reminded to keep individual data because they will be completing the laboratory report individually. **C INQ.5**

7. Think about the data you have collected. Do the data for each trial seem reasonable? If not, do you need to repeat any trials to correct any **errors**?

Teacher notes: Encourage students to look do multiple trials, and to look for data that does not fit the pattern. **C INQ.5**

8. **Analyze** the data.

Teacher notes: Students may need guidance in how to calculate the pulling force needed to overcome the friction force. Remind students that appropriate units are necessary. **C INQ.6**

9. **Interpret** the data. Write your conclusions in your science notebook.

Teacher notes: What ***assumptions*** *can be made about friction and materials by interpreting the data from the experiment? Were there any surprises? What questions might require further testing?* **C INQ.8**

10. **Compare** your experimental design and results with others in your class.

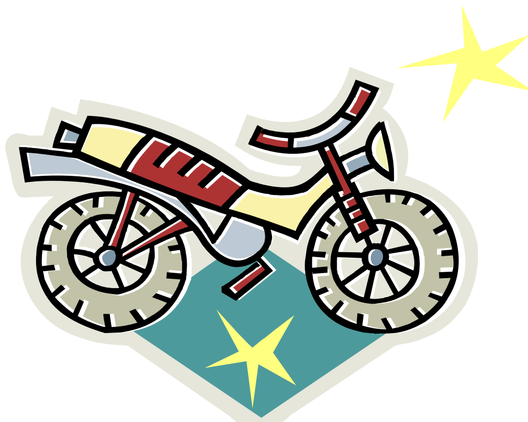
Teacher notes: Facilitate a post-lab discussion to compare methods and results. **C INQ.10**

Prompts can include:

- *Are your data reliable? How confident are you in the accuracy of your measurements?*

- *What are some potential errors that might have occurred during your experiment?*
- *How can you improve this experiment if you were to repeat it?*
- *What other factors affect friction that you could have investigated?*

Sometimes, people need to increase friction in order to perform a task. For example, adding ridges to a bicycle tire gives it better traction. At other times, people need to decrease friction. For example, grease is applied to the wheels of a bicycle to reduce friction and let the wheels spin easily.



In addition to the properties of the surface materials, what other factors do you think might affect friction?

Teacher notes: Lead a class discussion during which possible factors are listed. **C INQ.1**

Experiment #2: Effect of Mass or Surface Area on Friction Force

Design and conduct an experiment to explore one of these factors. Keep a detailed and organized record of your experimental design, data collection and analysis in your science notebook.

Teacher notes: Students may also explore other factors that might affect friction.

1. What **ideas** do you have about the way in which mass or surface area might affect friction? Discuss your ideas and predictions with your partners.

Teacher notes: **CINQ.1**

2. Identify the **question** you will investigate and the results you **predict**.

Teacher notes: Check that students mention both an independent and a dependent variable (cause and effect). Students may change the mass of the block and leave the surface area constant or they may change the surface area and keep the mass of the block constant. **CINQ.1**

3. Design a **procedure** to collect data to answer your research question. Identify the **independent** and **dependent** variables in your experiment. Think about the parts of your experiment that should be kept **constant** so you can collect consistent data.

Teacher notes: Mass can be altered by adding washers to the top of the block. Surface area can be an altered by rotating the block. **C INQ.4**

4. Write your procedure in your science notebook. Include enough detail so that you or someone else could repeat your experiment.

Teacher notes: **C INQ.3**

5. Create a **data table** to record data related to your experiment.

Teacher notes: Students should draw on their previous experience in Experiment #1 to design a data table appropriate for their experiment. **C INQ.5**

6. Do your experiment and **record** your findings in your data table.

Teacher notes: **C INQ.5**

7. Think about the data you have collected. Do the data for each trial seem generally consistent? If not, do you need to repeat any trials to correct any **errors**?

Teacher notes: **C INQ.8**

8. **Analyze** the data. Show your calculations in your science notebook.

Teacher notes: If students varied the mass of the box, calculate the mass of washers on the box. If they varied the surface area, calculate the area of the box in contact with the floor. Then, average the number (or mass) of small washers needed to start the box moving in all of the trials. **C INQ.6**

9. **Graph** your analyzed data. Think about the most appropriate type of graph to show a relationship between two variables.

Teacher notes: Students may need guidance in deciding the appropriate graph to represent the data. In addition, some students may require assistance in the construction of their graph. **CINQ.7**

10. **Interpret** the data. Based on your experiment, what conclusions can you make about the effect of surface area or mass on the friction between two surfaces?

Teacher notes: **C INQ.8**

11. Share and compare your results with others in your class. How were they alike? How were they different?

Teacher notes: **C INQ.10**

Communicate Your Findings

Use the findings from your friction experiments to solve the sliding box problem. Talk with your partners about what changes might be made to the shipping boxes, the way the TVs are packed in the boxes, or the cargo room floor to increase the friction and reduce the sliding.

Write a Report:

Write a report to the TV manufacturer or the shipping company describing your research and recommendations for reducing the sliding of the shipping boxes.

Your report should include:

- a clear statement of the problem you investigated;
- a description of the experiments you carried out;
- the results of your experiments (including data presented in the form of charts, tables or graphs);
- your conclusions from the experiments;
- comments about how experimental errors may have affected your results; and
- a recommendation to the company about changes that should be made to the shipping boxes or the cargo room floor to reduce the sliding box problem on the ship.

Teacher notes: **C INQ.10**

Teaching Resources

MORE FRICTION EXPERIMENTS:

http://www.ce.berkeley.edu/~dakon/friction/ - an actual floor friction experiment conducted at a seismic laboratory in California.

http://www.bbc.co.uk/schools/scienceclips/ages/8_9/friction.shtml - animated friction experiments in a "cartoon" format.

FRICTION WEBSITES FOR STUDENTS:

FRICTION WEBSITES FOR TEACHERS: