



## Using Thinking Skills as a Bridge between ELA and Science Teaching Strategies

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### ABSTRACT

This article presents five activities that demonstrate how developing thinking skills in students, uses comparable ELA and science skills. The thinking skills of Blooms Taxonomy are the organizer. Skills and processes gleaned from NYS ELA and Science Standards included in article are: categorizing, comparing, following procedures, sequencing, questioning, explaining, and making informed decisions.

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### Introduction

One way to promote integration of content disciplines is to look at the skills and activities that overlap according to discipline standards. The ways that students learn these skills best does not change by discipline. Thinking skills are one set of skills that can be taught across many disciplines. Some skills lend themselves better to certain content areas. Research says that no matter what skills students are taught they should have multiple opportunities in different situations to practice these skills in order for deep learning to take place (Caine and Caine, 2004; Bransford, Brown & Cocking, 2000).

Few books offer ways to bridge the disciplines, but *Science and Writing Connections: A Handbook for Teachers* focuses directly on how the writing process can enhance student learning in science (Harris-Freedman, 1999). I have had many opportunities to cross teach, being certified in both Language Arts and Science. I have found that one way to open profitable lines of communication between disciplines is through discussions of thinking skills at points where NYS standards overlap.

One way of organizing these connections is by extracting like statements from ELA and Science standards and place them side by side using Bloom's Cognitive Taxonomy. The standards statements are vague in that there are no specific examples on how you might teach skills that match them. The five activities described in this article fit both ELA and science standards and are specific examples on how these thinking skills might be taught. I have included graphic organizers as they are an effective pre-writing tool and help students to organize their thoughts (Harris-Freedman, 1999). *Table 1* shows



relationships between ELA and Science skills and processes using Blooms Cognitive Taxonomy as an organizer.

*Table 1. A Comparison of ELA and Science Thinking Skills to Bloom’s Taxonomy*

Bloom’s Taxonomy: Cognitive Domain	Language Arts skill/process Excerpts from ELA standards 1,3, & 4 at the 8th grade level 2005 revision	Science skill/process Excerpts from the Intermediate level Core Curriculum 5-8 USNY/SED 1996
Knowledge—the facts (Activity 1)	Connect, compare, and contrast ideas and information.	Categorizing
Comprehension—interpret and explain (Activity 1)	Compare and contrast information from a variety of different sources. Make, confirm, or revise predictions.	Comparing
Application—apply concepts to new situations. (Activity 2)	Read and follow written multi-step directions or procedures.	Follow procedures
Analysis—discriminate and divide (Activity 3)	Ask and respond to questions to clarify information.	Questioning
Synthesis—combine and integrate (Activity 4)	Identify appropriate format for sharing information with intended audience and comply with the accepted features of that format.	Communicate scientific procedures and explanations.
Evaluation—appraise and judge with evidence to support judgment (Activity 5)	Form an opinion or judgment about the validity and accuracy of information, ideas, opinions, issues, themes, and experiences.	Make informed decisions.

### **Connecting Activity 1: Bloom’s-- Knowledge and Comprehension Using a Dichotomous Key**

STANDARDS: ELA: Connect, compare, and contrast ideas and information  
Science: Categorizing

In this activity students practice their abilities to observe, connect, compare and contrast using observable characteristics of things. Practice helps with the development of rich language details and helps students develop a working knowledge of the differences between observable characteristics, e.g. wings (what you see) and inferences, e.g. appendages for flight (what it does). It is a learning lesson on the way to hierarchal reclassification abilities, and building specific vocabulary. In ELA this type of activity can help to build rich descriptions, in drafting essays and for poetry.

For younger learners, classification skills begin simply by sorting various items, first by a single characteristic, then by several characteristics, finally by several characteristics simultaneously. For older students, use several different sets of objects to



help them practice their abilities to separate objects according to observable characteristics with: tree leaves, fossils, plastic animals, lab equipment, different metals, beans, nuts and bolts, army men, school supplies and players on the Buffalo Bills NY Yankees. Sorting, ordering, sequencing and identifying characteristics are all part of the knowledge base necessary to create a dichotomous key, a basic scientific tool used in science to identify living organisms.

#### *Learning In the ELA Classroom*

1. Enlarge and laminate the graphic organizer so that there is space for a question, and then spaces to place items. These organizers help students separate objects by observable characteristics. Depending on your topic, gather up sets of 8 items for each group of students. Define dichotomy, observable and inferred characteristics. Students will use the graphic organizer to sort items into two groups using a question at each juncture. Dichotomous (dichotomy) means division into two parts. A Dichotomous Key is designed so that when each question is answered, the examined items are divided into two parts. The question format in science is: Does \_\_\_\_\_ have this particular observable characteristic? If the characteristic is present the item is sorted to the **Yes** side, if not, it is sorted to the **No** side.

2. Have students separate items by observable characteristics. The discussion that accompanies this task should be rich in descriptive language. They should use their journal to duplicate the graphic organizer and make a list of what items were sorted at each level. They should list the question first; then, which items had the characteristic and which didn't. Repeat with each group of separated items until all items stand alone.

3. There are two ways to check for correctness. (1) At each juncture, make a list of items that have and have not the specified characteristic. (2) When all items are separated, orally share each route the object took.

4. Discuss. Include in your discussion the power of vocabulary and how knowing roots of words and special descriptive words builds capacity for this thinking activity.

#### *Assessment*

Assessment takes the form of using appropriate vocabulary to describe an item, and to be able to successfully divide several items by different observable characteristics. There are many correct ways to complete this assignment. In fact one learning tool is to ask students if they can sort the items another way?

#### *Connections to Science Instruction*

Dichotomous key skills are tested in the performance sections of the Elementary Level Science Test (4th grade) and Intermediate Level Science Test (8th grade). Students are better able to understand the structure of dichotomous keys and begin to learn the specific words that describe the items in which they are interested, when they have a chance to sort with many different sets of objects i.e., rocks, minerals, gems, trees, fossils, plants, animals and others. One effective science classroom assessment consists of students' first making a key using several items. Then these keys and sets of items are switched between groups or classes for a check from other students.



Figure 1. Dichotomous Key Graphic Organizer  
Classifying by Observable Characteristics

Group Names \_\_\_\_\_

Question 1: \_\_\_\_\_

1a. Yes! Has the characteristic	1b. No! Does not have the characteristic
Question 2a	Question 2b

2a Yes	2a No	2b Yes	2b No
Question 3a	Question 3b	Question 3c	Question 3d

3a Yes	3a No	3b Yes	3b No	3c Yes	3c No	3d Yes	3d No
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**Connecting Activity 2: Bloom's—Application Following Procedures using *Origami***

STANDARDS: ELA: Read and follow written multi-step directions or procedures

Science: Follow procedures

Success in application tasks depends on student's abilities to be able to follow multi-step directions. Focus on following one-step-at-a-time procedures is hard for students because of all the distractions that disrupt their concentration. One way to help students learn to focus without distractions on following procedures is by connecting kinesthetic and oral learning with cognate learning through *Origami* (Marks-Tarlow, 1996).

The Japanese word *Origami* is from *ori*, to fold, and *kami*, paper. The young readers' novel, *Sadako and the Thousand Cranes* by Eleanor Coerr is used in many curriculums for young readers during the time when they are studying World War II. This novel has introduced *origami* into many elementary classrooms. You can use the art of *origami* to teach sequencing. You can also create paper art for your classroom. This past winter we saw a holiday tree trimmed with origami animals made by a group of fifth graders.



The two activities described help students see that there is a sequence that must be followed to achieve success in paper folding. This success leads to a completed figure. If the procedure at any step is changed a different figure may be made. Constructing *origami* figures may be used as a metaphor to help students develop ideas from simple to complex, yet still remembering the sequence of development. They might also be used in story writing and reading where you stop and ask *what happens next? What if we change this event, how will the rest of the story change?* Stories have so many possible endings, so it is with *origami* from the basic bases to variety different figures.

### *Learning in the ELA Classroom*

#### A. Introductory Activity.

1. Prepare several *origami* figures, one paper for each step of the figure and place them in a plastic bag or envelop. Use about 5 different figures so that participants can compare ideas. *Origami* figures with 5-7 steps will work for this activity (Gross, 2001; Petty, 2006).

2. Group students.

3. Before you hand out the bags, state the rules. The group is to remove the several pieces of folded paper from the bag and sort them into a sequence that makes sense to them. They are to do this SILENTLY, no verbal communication. Hand out materials. Say, "Begin." You must be SILENT as well.

4. Wait for all groups to complete task. Discuss the sequencing and the reason for silence. Questions you might use to encourage discussion include:

*Why is it important to follow exact directions?*

*What would happen if the sequence were done some other way?*

*How can we be sure that our work is completed sequentially?*

*Why is it important to follow procedures exactly? (medicine, automobiles, computer startup)*

#### B. Building Capacity Activities for other days.

1. Hand out and/or show students the basic folds and bases of *origami*.

2. Record directions for folding a specific figure on a tape as in the *Connections to Science Instruction* section. Play it when you have time or desire for students to practice following directions. Remember that as your students become better at listening and folding, the figures should become harder and with more steps. Initially, five to seven steps to a complete figure are sufficient.

3. (Extension) For those who enjoy *origami*, you may wish to set up mystery figures, with students creating directions to show how it is folded. You might start with a base fold and ask for several figures that could be folded from a base such as bird, frog, kite, or water bomb bases.



### *Assessment*

No assessment is necessary but your observations regarding an improvement in students' abilities to follow procedures are desirable. I make cranes, especially golden cranes for perfect attendance and silver butterflies for exceptional work.

### *Connections to Science Instruction*

One chemistry teacher used paper folding to teach her students, (a) to listen to oral instructions and (b) to follow instructions quickly and accurately. She audio recorded directions for a paper figure and at the beginning or end of a class, played them to her students. They all were required to fold the object to the best of their ability. She had already given them simple directions to the names and kinds of folds used in paper folding. She found that after the 4th figure students were quick, and anticipated the next instruction. She also found that all students were better at not only following procedures in her laboratory work, but they improved in writing procedures. This was her objective!

A multi-paper element *origami* structures can be used to model the importance of precision and tolerance limits. Each piece must be folded within certain standards to fit with others. I used this assignment to (a) demonstrate experimental error, (b) working to specifications within tolerance ranges and (c) repetition of work at a given standard. It was amazing how a little paper folding activity provided examples of these important scientific concepts (Gross, 2001; Petty, 2006).

### **Connecting Activity 3: Bloom's—Analysis using 6 W & H Question Prompts**

STANDARDS: ELA: Ask and Respond to Questions to Clarify Information

Science: Questioning

Analysis, the ability to discriminate and divide ideas is a higher order thinking skill that takes a lot of practice to develop. This activity gives students prompts, 6 W & H, to aid them in practicing analysis.

Six W & H questioning is a strategy in which students generate questions starting with the words: *who, what, where, when, which, why, and how*. Simple “yes” or “no” questions are eliminated from this activity. Who, where, which, and when can produce descriptive, recall, ordering, and comparative questions. What, why, and how can produce higher-order thinking questions. Newspaper reporters have a way of producing an article by answering the 6 W & H questions. For students, you can use this technique to develop a short essay or an analysis of a topic or concept.

In ELA you might do this activity with political cartoons or book covers to find out prior knowledge from your students regarding concepts and theories. Depending on your purpose for analysis, you might have the same or different visual prompts for your students.

### *Learning in the ELA Classroom*

*I have described this as a preview activity. It could be used as a starter for a research project or as a review activity. In reviewing, index cards instead of whiteboards could be used so that the cards could be passed from group to group or class to class.*



1. Introduce your students to this analysis activity by having them list the 6 W & H question starters. Discuss different elements of analysis, discriminate and divide, and how questioning can lead to higher order answers in clarifying information.

2. Use small groups. Hand out a whiteboard and markers to each group. They should write the question starters on the board, leaving room to fill in the blanks with completed questions.

3. Identify your concept or topic in a pictorial way. Allow time for students to ask questions to clarify the topic. Then as a group, they develop as many of the 6 H & W questions that they can about the contents of the picture. They should write about what they know or what they would like to know.

4. After the allotted time, have small groups share the generated questions with the whole class.

5. Discuss results. As a way of evaluation, ask for comments on the visual prompt and use of whiteboards for this activity. Students may do this in the form of an exit slip. An exit slip is a question or request for information that students fill out and turn in as they leave class (Harris-Freedman, 1999, pp 34).

#### *Assessment*

Normally, you would not grade grammar on white-boarding as these questions are the results of brainstorming. If you are working on generating questions for research or areas of study, don't grade them at all. If you are looking for participation and cooperation grades, then participation in this activity could add to that grade. Student responses on the exit slips can be used to evaluate your instruction. Areas of strengths and weaknesses can be identified and changes in instruction made.

#### *Connections to Science Instruction*

This technique can be used when previewing a topic or concept. Sets of different or like photographs can be used to generating ideas or to find out student's prior knowledge. It can be used to generate questions for research or other assignments. After a preview, the teacher's job would be to use the gleaned information regarding student prior knowledge to guide instruction.

For review, students would create questions with answers. I used this activity to have students make up many review questions and then pass them out when we had a few extra minutes at the end of a period, or they used them as review the day before an exam. When the questions were student made, they seemed to pay more attention to them than when a teacher generated review sheet was used (Harris-Freedman, 1999, pp. 31-33). Somehow many of these questions found their way into more than one unit exam!

#### **Connecting Activity 4: Bloom's—Synthesis Using Different Points of View**

STANDARDS: ELA: Identify appropriate format for sharing information with intended audience

Science: Communicate scientific explanations



Synthesis is about combining and integrating ideas. This activity uses the same basic knowledge collected from research and investigations and integrates it in different ways; in this case writing from two or more points of view. Students like to think that there is only one point of view, theirs, and only one audience, themselves. Changing the audience in order to share learned information forces students to move from their egocentric point of view. They must learn to use different formats for writing. In this activity the task is writing from three different points of view (Harris-Freedman, 1994).

To challenge student's abilities to synthesize knowledge and show comprehension use *Fact* and *Fiction* writing side-by-side. Then add the style of *Persuasion* to bring more depth to students' abilities to explain and present information. Keeping to the *Facts* uses the lower-order thinking skill of description. Students show their knowledge and comprehension capabilities when writing in this style. Students might use the 6 W & H format for presenting the facts. *Fiction* writing makes use of students' ability to synthesize information. Students will have to keep to a short story format for this style of writing. *Persuasion* writing adds the format of developing logical arguments, arguments that must be supported by reliable evidence. All formats can be used separately until students are competent, then they can move on to the following.

#### *Learning in the ELA Classroom*

1. Explain that for this culminating activity students will be writing from two (three) different perspectives—factual, fictional and persuasive. Have students review the characteristic formats and audiences required for each style of writing. Then have the students list how they would show their understanding or learning using these multiple writing styles. These lists become the basis for a scoring guide. Doing this in class reinforces students' knowledge of the accepted writing style formats.

2. Design a scoring guide with students before they begin writing. Hand out writing prompts. Go over prompts so that the directions are clear for all. Depending on the time frame for this assignment, work would be done in class or at home. You may allow students to prepare drafts of their writing and then bring those in for the day of the exam.

3. If the assignment is intended as an exam, have students write in class. Otherwise, you can assign the writing as homework or use several days of class for students to develop their piece. For the kinds of details you would like in a final work, students might write a rough draft as homework and be able to use it to create a finished written and/or oral product in class.

#### *Assessment*

Point of view writing might be used for any number of essay assignments. Start students with a presentation of facts question. Then ask them a fictional one in which they have to apply the concepts. Then ask them to use their knowledge to persuade others to accept their point of view. This activity can be done as a summary for a unit, or at the end of a long-term investigation. Score student writing according to the scoring guide generated by students or one of your own making. Collect all drafts of student writing.

*Connections to Science Instruction*

In some science classrooms, students do little writing beyond laboratory reports and test essays. Writing from different points of view, expands their abilities to communicate in writing to several different audiences, something they will have to be able to do all of their lives. I've included prompts for science that you might share with a science teacher in your building. I find that asking for fictional accounts adds creative elements in students' writing that never show up in essay tests. Some students show better science understanding through their fiction writing than through any of their other traditional test answers.

*Example Writing Prompts for Science*

Concept: The Sun's energy

Fact: Draw a diagram and describe the processes involved as Sun's energy leaves the surface of the Sun, travels through space to the Earth's surface. Does 100% of the Sun's energy reach the earth? Explain.

Fiction: Write a story about what might happen to some of the Sun's energy as it leaves the Sun and travels through space to arrive at the Earth. What happens when it reaches the atmosphere? Maybe it travels to the surface where it is recorded by one of our science experiments. Pretend you are a bit of the Sun's energy. Describe your journey. Where do you come to rest, or do you? (Harris, 1994, p. 59).

Persuasion: You are the director of a solar energy company. Write a pamphlet that will persuade your county to invest in solar energy use.

Concept: Geologic Time and Earth's history

Fact: Earth's history is divided into four major eras: Pre-Cambrian, Paleozoic, Cenozoic, and Mesozoic. Use the research and activities we have completed in class to describe ONE era. Remember to include information about biological and physical changes in the environment that affected life during that era. Include major events that determined the beginning and end to the era you choose (Harris, 1994, p. 45).

Fiction: You have set your time machine for one of the four major eras in Earth's history. Identify the era, when and where you have landed. Describe your first ten minutes in that era.

Persuasion: You are a paleontologist and would like to continue to be able to collect fossils and have them stay in the possession of your university for research. Write a report that supports your case for intellectual and academic freedom. Address it to the US Senate Committee that is preparing a bill to stop all fossil collecting.

Concept: Space Exploration ISS

Fact: Describe the history and current status of the International Space Station (ISS). How much money has been spent? Please show the budget outlay of each country. What is currently happening with the ISS and how can we involve ourselves with this project?



Fiction: Pick one of the astronaut-specialists that is/ or was working on the ISS in 2025. Write 10 daily journal entries for this person. Include what is happening at their job.

What are their daily challenges? What are they thinking?

Persuasion: You are the chair of NASA's ISS committee. Congress wants to cut funding. With your group's help, set up a presentation to persuade the congressional committee not to cut funding, but in fact to increase federal funding.

### **Connecting Activity 5: Bloom's—Evaluation: Organizing and Validating Information that is used in Decision Making**

STANDARDS: ELA: Form an opinion or judgment about the validity and accuracy of information, ideas, opinions, issues, themes and experiences.

Science: Make informed decisions.

We make many decisions during the course of a day. How many of these do we think about the risks, consequences, costs, actions and evidence to support each element before we make a decision? If we went into such great detail with each decision, we would not accomplish very much, but when we have a difficult decision or a specific problem to solve we need to make the best choice that we can with the information we know or can find out.

Making informed decisions based on evidence is logical and complex. It includes (a) making a judgment and (b) supporting it with valid evidence. Students have a hard time sorting out the subjective from objective, and their misconceptions from reality. This is especially true in science. There are simple ways of organizing information, so that it can be helpful in decision-making and problem solving. Graphic organizers are one way to help organize information.

Graphic organizers can be used whenever there is more than one aspect to an issue, problem or a decision. What is important is that (a) the elements of a graphic organizer be set up in advance of the research; and (b) that important aspects can be added to the graphic organizer when they are discovered. For younger and less sophisticated learners a simple Pro and Con template will get them started in evaluation skills. Two points of view are harder to present than one!

#### *Learning in the ELA Classroom*

Before the lesson: Use pre-made or class developed graphic organizer to organize research material. This may be from investigations, secondary research or by other data gathering activities. Use the class generated credibility table to evaluate your sources. Discuss the elements of making informed decisions and then supporting your ideas with credible evidence.

1. In your course of study, you may present an issue or problem that needs solving. You might use this graphic organizer for students to sum up the major events in current readings before students read the next section of a story. They might also research a *what if the author chose a different ending* type of assignment. Some beginning or sample prompts might include:



- Personal decisions as simple as, “*What could happen to me if I went for a walk?*”
- Societal, “*What should be done about waste disposal (toxic, everyday garbage, as a by-product of technology)?*”
- Historical: *What could we have done better in the treatment of returning Viet Nam Veterans?*
- Current: *What can we do on a personal level to minimize global warming?*

2. Pass out the Credibility Scoring Guide. Discuss the validity and why some information is more credible than other.

Credibility Scoring Guide developed by Graduate Students for use in their classrooms at Buffalo State College, Spring 2003 (Penick and Harris, 2005, p 48).

	4	3	2	1
Reflects my topic, supports my topic	In the title, and permeated throughout the article	In some sections	Mentioned	Found in word search
Credible	Written by established expert in the field, Data analysis	Peer reviewed	Cites established experts	Journal or organization has a positive reputation in the field
Data to support claims	Level of significance Description of population inferences	Methods, what kind of data is collected, reliability and validity information	Mismatch between claims and data	No data at all, Or got it from an IM from a friend
WEB-Credibility	On line Peer reviewed journal or publication	Reputable sponsor References national organizations such as NSF, NASA, NOAA,	Associated with college or university	Amazon.com Local newspaper, found in a blog, or in wikipedia

Note. Level 4 is the most desirable level of credibility

3. Pass out the Evaluation Information Data Sheet graphic organizer and discuss how to use it to organize information. The one included in this article pertains to the resolution of an issue that has many elements that must be considered before making a decision (adapted from Nagel and Seigel, 2004). Student groups would complete all three parts.



Evaluation Information Data Sheet

Names of Group Members \_\_\_\_\_

Identify Issue \_\_\_\_\_

A. Fill in table with your research regarding:

Element /Risk	Associated consequences	Possible Actions	Evidence that does/does not support this action	Costs* associated with this action

\* Loss of quality of life, loss of abilities, financial, social, cultural (Note, add more rows and expand the cells of the table as you identify more elements.)

B. When you have identified and researched each element/risk, prioritize the actions by prescribed criteria provided by your teacher.

C. Outline your Evaluation by stating the problem or decision to be made, the associated risk/elements, supported by evidence. Present your groups' evaluation on what should be done first, second, third, or never in regards to this issue.

4. Students conduct investigations and research to acquire information.

5. Before groups make their decision and write up their explanation with evidence, they should weigh the credibility of their evidence. Focus questions you might use could be, "Should you choose your course of actions based on a specific piece of evidence? What is that evidences credibility rating? Is there other evidence that supports your choice?" Discuss why evidence with level 1 rating should not be the only basis for making a difficult or challenging decision.

6. Students make their decision and present it in the format decided by the teacher. Posters are one way to share information with a large group and facilitate oral presentations. Graphic Organizers are turned in with the final product.

Assessment

Assessing graphic organizer work before the completion of a final presentation, will add to the quality of the final work. As any drafting writing is scored, look for ways of improvement and make your comments as questions. For the final product and the graphic organizer, you should have a scoring guide that includes both quality and quantity elements. I use three pieces of evidence, with credibility scores of 4 or 3, from three different sources to support any decision.



### *Connections to Science Instruction*

Graphic organizers help students organize information and can be used for many pre-writing and research based activities. They help students to visualize (a) the many parts, (b) the risks and benefits in supporting a decision or the (c) trade-offs, in solving a problem.

Elements of graphic organizers will change depending on the simplicity or complexity of an issue, problem or decision to be made. The graphic organizer presented here is a composite that should provoke discussion. What is important is that we are providing a template to organize information that will aid in evaluating issues and making decisions.

### **Conclusion**

ELA and Science standards have similar ideas and concepts that are taught in our classrooms. Translating them into day-to-day activities in more than one discipline can lead to building connections in skills and process in students' minds. As students learn and practice these skills in a variety of settings, their personal knowledge is increased. This article presents five ways to bridge the disciplines of ELA and Science through thinking skills.

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- \_\_\_\_\_ The Origami Kit. ISBN 1-58663-229-9, this multi-media package contains paper and a book titled *Origami: Easy-to-make Paper Creations* by Gay Merrill Gross.