WILLIAM & MARY
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Training & Technical Assistance Center

P.O. Box 8795
Williamsburg, VA 23187-8795

Science Strategies Considerations Packet

For more information contact:

E-mail: **ttacwm@wm.edu**

Phone: 757-221-6000 or 800-323-4489

Website: http://education.wm.edu/centers/ttac/index.php

Science Strategies

This *Considerations Packet* focuses on strategies teachers can incorporate into their instruction to enhance student learning in science. Students who manipulate scientific ideas using hands-on/minds-on strategies and activities are more successful than peers who are taught by teachers relying primarily on lecture and the textbook (Lynch & Zenchak, 2002). Effective science instruction capitalizes on questioning, offers opportunities for students to integrate prior knowledge with new information and skills, and encourages reflection (Leonard, Gerace, & Dufresne, 1999). Encouraging student inquiry in an environment where lab safety practices are followed results in students developing research skills and thinking processes to be used in other problem-solving situations. While science laboratories and flat tables are nice, science investigations can be conducted anywhere!

Strategies used successfully in other subject areas may also be appropriate when teaching science. A table at the end of this packet highlights such strategies featured in other *Considerations Packets.* This Science Strategies packet is divided into five strands focusing on: Organizing and Remembering Information in Science, Reading in Science, Writing and Reflecting in Science, Learning Together in Science, and Investigating in Science.

Organizing and Remembering Information in Science

Mnemonics (Mastropieri & Scruggs, 1991)
This tool helps students in remembering items by using the first letter of each word to make a new word or sentence. For example:

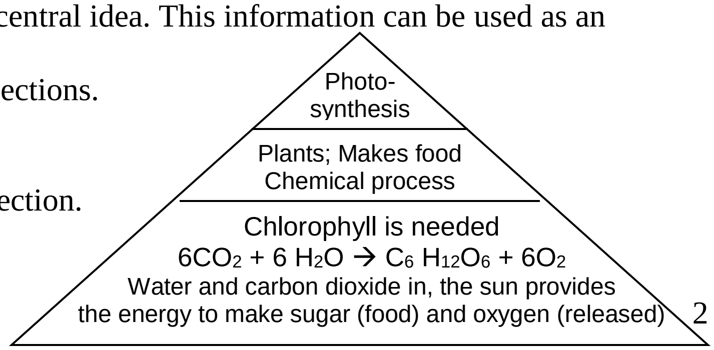
- *ROY G. BIV* for the colors in a rainbow (red, orange, yellow, green, blue, indigo, violet).
- *Pat made fruit pies already.* This is used for remembering the five kingdoms of living things (Protist, Monera, Fungi, Plant, Animal).

Odd-one-out (Wellington & Osborne, 2001)
This strategy requires students to use what they know about a topic to identify the item that does not belong when given a choice of items. This works well with items that can be classified, such as simple and complex machines, organisms, chemicals, and renewable and nonrenewable resources.

1. Identify the concept or topic area.
2. Select several examples from that area.
3. Make a nonexample that does not fit.
4. Have a partner or group member tell which item does not belong and why.

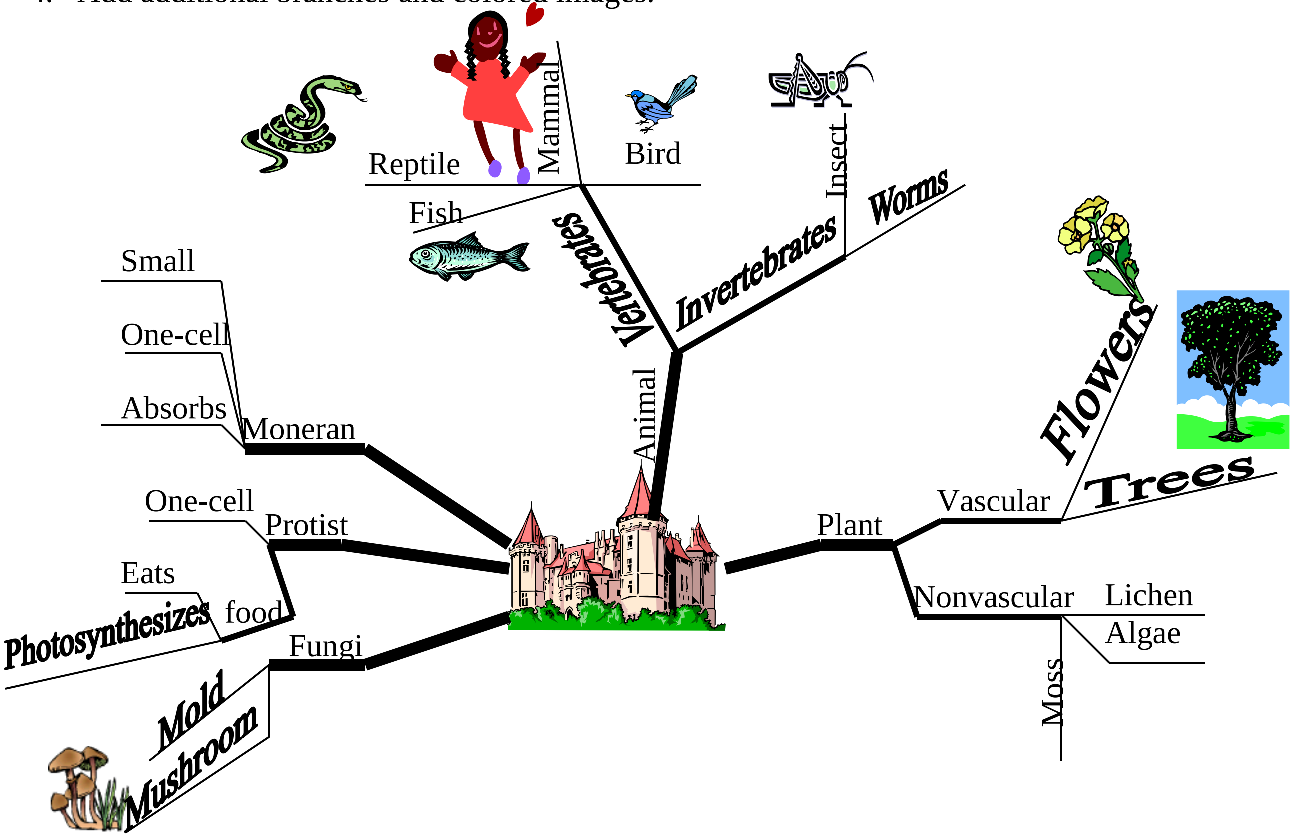
Science Facts Triangle (Thier & Daviss, 2002)
This strategy divides information on a topic into three parts. By relating each section to the one above it, students can expand their knowledge from a central idea. This information can be used as an advanced organizer in addition to a study tool.

1. Draw a triangle and divide it into three sections.
2. Place the main idea in the top section.
3. Write key facts in the middle section.
4. Place supporting details in the bottom section.



Mind Map (Buzan, 1991)
Mind mapping is a visual tool that helps students remember and associate key words and concepts.

1. Place a colored image in the center of a piece of a paper.
2. Branch the main ideas off of the center image using a single word.
    a. Print words on thick lines
    b. Use additional colored images to stimulate the brain
3. Elaborate on the main ideas using thin lines connecting to the thick lines with a printed word above them.
4. Add additional branches and colored images.



NOTE Mind Mapping is one way to organize information. Other approaches include advanced organizers, Thinking Maps©, and graphic organizers. Software programs such as Inspiration©, Kidspiration©, Thinking Maps©, and others may be used to support students; they are provided merely as examples and their mention is not intended to be construed as an endorsement.

Reading in Science

DARTS: Directed Activity for Reading Texts (Wellington & Osborne, 2001)
This activity uses text or diagrams to focus students on finding specific information. Depending on the level of the student, the teacher may want to include a word bank.

1. Select a reading passage and an accompanying diagram.
2. Remove the words in the text that correspond to the labels on the diagram.
3. Instruct the students to use the context clues in the passage to identify which label on the diagram belongs in the blank.

Students could use the text to label the diagram as an alternative activity.
Guided Imagery (Thier & Daviss, 2002; Walker & Wilson, 1991)
This strategy helps students relate abstract or unfamiliar scientific concepts to their own lives. Students could write their own guided imagery passages after hearing it modeled and being instructed on the elements of "good guided imagery" writing.

Teacher preparation:

1. Select a relatively short passage or a section of a longer one from the textbook, for example, nocturnal animals.
2. Identify the key ideas and phrases in the textbook relating to the concept. Still using the nocturnal animals, this could include the ideas that they have adapted to see in the dark, sleep during the day, and feed during the night.
3. Develop an analogy that captures the ideas associated with the concept. Include sensory statements, repeat key ideas, and remember to write in a statement so students know the experience is ending. For example, the key idea is that nocturnal animals are active when people typically sleep.

The camp grew quiet as people climbed into their sleeping bags and turned off their flashlights. As the children drifted off to sleep, they heard the sounds of the forest, the trees and branches moving, the owls "hooing," crickets were chirping. Later that night, you wake up to go to the camp latrine (outdoor bathroom), you unzip your sleeping bag and leave your tent with your flashlight in hand pointing down to the ground to light your path. You trip over a tree root and your flashlight rolls a little in front of you. As you get up, you are startled to see two big glowing eyes looking down at you. You rub your eyes and look into the tree again and hear the owl call "Hoo Hoo." He looks around with those big eyes. Suddenly he takes off, his wings outstretched against the bright moon. You don't know where he went probably to catch his dinner.

The teacher could also identify a selection from literature to use. For example, in a discussion on nocturnal animals, the teacher may choose a book such as *Owl Moon* by Jane Yolen and illustrated by John Schoenherr. Identify a key passage to use to describe what the young girl and her father experience as they seek the great horned owl.

Instructional delivery:

4. Tell students that as the passage is read, they are to imagine what they would see, smell, feel, and hear.
5. Ask students to close their eyes and relax.
6. Read the passage.
7. Lead students in a discussion of what they "saw."
   Optional activity: Ask students to open their eyes and describe what they imagined to a neighbor, in their science logs, or by sketching and writing a caption.

Reading Frames (Armbruster, 1991; Royce & Wiley, 1996)
This strategy assists students in recognizing essential information while reading science textbooks, books, articles, or webpages. Provide students with a table with headings related to a selection of text and have them fill in the details.

Organism	Form(s) of Locomotion	Warm Blooded or Cold Blooded	Reproduction	Example(s)
Amphibians				
Birds				
Fish				
Mammals				
Reptiles				

Writing and Reflecting in Science

Issues, Evidence, and You (Thier & Daviss, 2002)
This approach encourages students to consider the implications of science knowledge, actions, and/or current events. Working individually or in small groups, students read an article, brainstorm the issues, evidence, and implications, and write an essay. The first paragraph frames the issue, the second paragraph provides the statement of the facts. Evidence in the second paragraph should support the conclusions drawn. In the final paragraph, students apply the information to their own lives, considering the implications for them.

Science Logs (Santa & Havens, 1991; Thier & Daviss, 2002)
This strategy can be used at any point in the lesson. Science logs encourage students to think about what they know, what questions they have before the lesson, what they have learned, and what additional questions have been generated after the lesson. Science logs are introduced as places where students will write about their experiences in science, including their observations, questions, and insights.

- *For reading selections:* Have students write what they know about the topic before reading the selection. Next, let students make another entry about what they remember from the reading. Finally, at the end of the lesson, have students write what they learned. Let volunteers share their entries and discuss questions that arise.
- *For observation activities:* Encourage students to write not only their observations, but the questions they form as they examine the organism or phenomena.
- *For science reports:* Have students record the purpose, problem, hypothesis, materials, procedures, and data from results along with their discussion and the conclusions. Encourage students to modify their logs in another color of ink with additional information or changes based on the class discussion of a lab.

Experimental Design Diagram (Cothron, Giese, & Rezba, 1989)
This diagram conveys the essential elements of a science experiment in a quick written format.

Title: The Effect of Temperature on Seed Germination
Hypothesis: Seeds placed over the heat duct will germinate the fastest.

IV: (independent variable/what is changed) Temperature			
	25◦C (Control)	15◦C	35◦C
Trial 1	5	10	5
Trial 2	6	9	4
Trial 3	7	12	3
Average	6	10.3	4

DV: (dependent variable/what is measured) Days
C: (constants/what stayed the same throughout the experiment) Type of seed, container, water source, time of day observed, light level

Learning Together in Science

STAD: Student Teams Achievement Division (Slavin, 1995)
In this strategy, students work together in four-person heterogeneous teams to support the learning of each of their team members.

1. Assign students to teams.
2. Have team members work together on learning activities, and so on, to coach each other and ensure that each has mastered the knowledge and skills from the lesson. They may compare answers, discuss questions, and help each other on class work.
3. Give assessments such as quizzes and tests individually. Students earn their own grades. Based upon their current individual performance compared to past performance, the team is awarded points to form a team score. The team earns points if students meet or exceed previous performance. *NOTE* High-performing students earn the maximum number of points if they maintain their performance as grading scales "top out."

Group Investigation (Lazarowitz, 1995)
In this cooperative learning approach, students are responsible for much of the decision-making process.

1. Form group investigation teams based on criteria such as student abilities, who they have not worked with in the past, or random assignment (could have students draw playing cards - students with the same card work together).
2. Provide students with a focus area for determining a topic for investigation.
3. Have students plan how they will investigate the topic, including what materials they will need, people they should interview, and activities they want to do.
4. Review the plans submitted/presented with the students and offer targeted feedback.
5. Monitor students as they work on the investigation.
6. Provide a forum for students to report on their findings.

FOSS: Full Option Science System (Jarrett, 1999)
In this cooperative learning strategy, mixed-ability students assume roles in a group to work on an activity together. It is particularly useful in situations with limited materials and space, such as a lab. All students are responsible for learning the material and participating in the activity.

1. Assign students to groups of four.
2. Explain the four roles to the students. One suggestion is to have a:
   - reader who reads all the instructions or related selections;
   - recorder who writes the group's hypothesis, observations and findings, and conclusions;
   - getter who gets items needed for the lab. This is the only person who can move about the room (e.g., to get water, throw away trash, collect and return supplies); and
   - timer who ensures the group starts the activity, keeps track of how much time is left, times everything in the experiment, and ensures the group finishes in the allotted time.
3. Inform students that the roles rotate each class period. One suggestion for managing this is to have nametags listing the various "jobs." Responsibilities for the jobs may be printed on the nametags as reminders of the duties for each role. Students can sign the back of the nametag each time they assume a role; everyone must try each job for one lesson before repeating.
4. Have students put on the nametags.
5. Tell students about the activity. Steps 1-4 become automatic when students are told to get into their science groups with a little reinforcement.

Investigating in Science

3-2-1 (Thier & Daviss, 2002)
This strategy assists students in discerning between an observation and an inference.

1. Provide an event for students to observe. Examples include:
   - An organism such as a hatching chick or butterflies emerging from cocoons
   - A chemical reaction
   - An unfamiliar substance such as "oobleck" made from cornstarch, water, food dye, and vanilla that feels like a solid when struck, runs like a liquid, and dries into a powder when rubbed
   - A tropism
   - A change in states of matter, for example, an ice cube being heated, becoming water, and then evaporating as water vapor (gas)
2. Ask students what they saw, heard, and/or smelled.
3. Instruct students to infer what these observations mean.
4. Ask students what questions they have about the event.

Optional written format: Have students divide their paper into thirds to form the table shown below.

3 Observations I've Made	2 Inferences	3 Questions I have

4-Question Strategy (Cothron, Giese, & Rezba, 1989, p. 33)
This strategy encourages students to think about how an investigation could be designed based on what they know and have available for experimentation. Once students have identified a question that they want answered, they need to consider:

1. What materials are readily available for conducting experiments on __________?
2. How does ___________ act?
3. How can you change the set of __________ materials to affect the action?
4. How can you measure or describe the response of __________ to the change?

Students make additional decisions. For example, they decide on an item from Question #3 to be the independent variable. This item must have multiple levels, such as varying amounts, different temperatures, or exposure times. A control needs to be identified where nothing is manipulated as well as a dependent variable (Question #4) so the experiment can be measured, timed, and so on. All items (constants) that are used are listed regardless of the independent variable level. Next, students write the procedures for the experiment. Finally, students write a hypothesis (what they think will happen). Before letting students conduct the experiment, the teacher must approve the research plan.

Questioning to Engage Students in Inquiry (Carin & Bass, 1997)
This is just one of many questioning strategies in the literature. Its purpose is to encourage students to use what they already know as the foundation for considering new information. The questioning strategy may be used to encourage students to apply what they know about erosion to concerns of human impact on the environment. This example is shown in bold.

Engage

1. Ask questions of students to assess their prior knowledge (offers a starting point).
   How do people affect the environment?
2. Lead students in formulating questions about a topic or an event they experienced.
   Tell me about a time when something you did impacted nature.

Explore

3. Inquire about what students have observed. **Take a walking tour around the school grounds.**

Explain

4. Encourage students to offer hypotheses, inferences, or ideas about why something happened. Try to get them to use their own questions to lead them to explanations of the phenomena.
   Why does erosion occur near the construction of the new playground?

Elaborate

5. Pose situations and ask students to apply what they know to solve the problem in a different setting. **Erosion due to construction, rivers, cutting down trees.**
6. Suggest questions where students need to weigh the benefits and the risks of different courses of action in particular situations. **The Ecology Club is making a hiking trail on a hill in the park near the school. What would be the best way to construct the trail?**

Respond

7. Acknowledge and reinforce students with constructive feedback.
8. Clarify and compare responses, offering suggestions and corrections as needed.
9. Encourage students to probe deeper into the topic and strategize with them on how they can do this. **(Steps 7-9 are about encouraging student reflection in response to what they offer.)**

Discrepant Event (Carin & Bass, 1997; Friedl & Koontz, 2001)
This approach engages students in asking, "Why," as a way to activate students' thinking about a topic after they observe something that does not seem possible based on their prior experiences.

1. Setup a discrepant event.
    - Putting a can of diet soda and a can of regular soda in a tub of water results in one of the 12 oz. cans sinking and the other floating (density)
    - Adding 50 ml of rubbing alcohol and 50 ml of water together in a graduated cylinder and seeing less than 100 ml (particle size)
2. Provide time for students to investigate the discrepancy between what they thought they knew and what they observed.
3. Resolve the discrepancy by either students sharing what they discovered (optimal) or by asking leading questions or simply providing the explanation.

Conclusion

Science is a way to understand the natural world. The nature of science encourages people to ask questions, make hypotheses, test their understandings, and arrive at conclusions that often result in more questions. This content area encourages students to work together just as professional scientists do (Hurd, 2001). Effective teachers use instructional strategies to maximize their students' learning experiences by:

- accommodating for students' learning needs
- adapting the curriculum, emphasizing student understanding
- facilitating the inquiry process
- offering opportunities for students to engage in scientific dialogue
- creating a positive classroom climate built on respect and cooperation
- encouraging students to share in the responsibility to learn (Texley & Wild, 1996).

The strategies offered in this *Considerations Packet* foster student learning and capitalize on students' desire to interact with others and understand the world around them.

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Additional Resources

Resources are available on loan through the T/TAC W&M library. Visit our website at http://education.wm.edu/centers/ttac/index.php for a complete listing of all materials. Select the *Library* link on the home page and search *science*.

Information about the following strategies is available in *Considerations Packets* that can be requested online at http://education.wm.edu/centers/ttac/resources/considerations/index.php. Select the *Considerations Packet* link on the home page. The name of the packet appears in italics on the table.

Strategy	**Description**	**Page**
Writing and Reflecting in Science		
Considerations: A "Word" About Vocabulary, 2001		
Semantic feature analysis	Facilitates students recognizing similarities and differences in words. Teachers pick a category that students know and make a list of concepts/objects in that category. Then students decide what to explore about those items in a particular category. The objects are written in a column while the items to explore are in a row. Next, students indicate in the matrix if the object possesses each item.	5
Word Alive	Encourages students to think about vocabulary by having them predict a word's meaning, look it up in the dictionary, rewrite the definition in their own words, identify synonyms and antonyms, sketch the word, and finally write a caption for an illustration of the word.	9
Reading in Science		
Considerations: Strategies for Teaching Inferential Reading Comprehension, 2002		
CLOZE	Assists students in using textual clues to fill in blanks in informational sentences. The teacher prepares a passage where key words are omitted (in the beginning one word may be missing from every couple of sentences). Students generate possible words to fill in the blank based on their knowledge of the text.	8
DRTA	DRTA stands for Directed Reading and Thinking Activity. It teaches ways to infer information and justify responses. Students predict what will happen, read, verify their predictions, and reevaluate their hypotheses.	9
Reciprocal Teaching	Allows students to observe how someone (i.e., their teacher) comprehends an unfamiliar reading selection by formulating questions, clarifying, summarizing, and predicting.	10
Think – Aloud	Used to demonstrate a thought process. Students verbalize what they are thinking as they perform a particular task, read a passage, or solve a problem to enable them to hear the inferences and choices that are being made.	5
Learning Together in Science		
Considerations: Techniques for Active Learning, 2000		
Jigsaw	Helps students become "experts" in an area and teach the related material to others in the "home" group. A teacher divides students into groups; each group learns something different. Then the teacher reassigns students so that there is one "expert" from each group in each newly formed group, called a "home" group. Each member of the "home" group is responsible for teaching their "home" team members what they learned.	4

Strategy	Description	Page
Peer Tutoring	Provides an opportunity for students to help same-age peers learn a concept through one-on-one interaction in which the tutor provides support and feedback to the tutee.	5
Think, Pair, Share	Encourages students to *think* about a topic and then *pair* to discuss with a partner before they *share* their thoughts with the larger class/group.	4
Investigating in Science *Considerations: Helping All Students Meet the Standards with Technology and Project-Based Instruction*, 2002		
Project-Based Learning	Facilitates students' use of prior and newly acquired knowledge and skills to work on a real-life problem. Typically, students work in small groups to identify the issue, design a means to address it, and create a product or presentation to share the findings.	1-12

This *Considerations Packet* was prepared by Jennifer L. Hindman, June 2003.