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Teacher-made Tactile Science Materials with Critical and Creative Thinking Activities for Learners Including those with Visual Impairments

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Teacher-made Tactile Science Materials with Critical and Creative Thinking Activities for Learners including those with Visual Impairments

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Other Contributors

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Abstract

Gifted students with visual impairments are twice exceptional learners and may not evidence their advanced science aptitudes without appropriate accommodations for learning science. However, effective tactile science teaching materials may be easily made. Recent research has shown that when tactile materials are used with *all* students in the class, everyone benefits. This presentation provides many classroom-tested example sets of tactile materials for teaching upper elementary and middle school science concepts. These science concepts include the parts of: a flower, ear, insect, beaver habitat, volcano, hydroelectric power plant, plant cell, and sun. Critical and creative thinking skill strategies to accompany these materials for further developing gifted students' science knowledge also are provided. These include application of the Edward de Bono CoRT Breadth thinking skills and other creative thinking skills, such as making a model or using analogy. This document represents the content of a gifted education conference presentation made at the Iowa Talented and Gifted Association Annual Meeting.

Acknowledgements

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Introduction

Visual impairment is a loss of sight that cannot be corrected through surgery, lenses, or medication. This condition limits a student's access to visual information. Students with visual impairment may be partially or completely blind, have poor visual acuity, and/ or a restricted range of peripheral vision, and/ or poor contrast sensitivity. Visual impairment may be congenital, the result of trauma, a disease, or a degenerative condition of the eyes, brain, or nervous system. Students who are nearly or totally blind cannot see and depend upon their other senses, often the sense of touch.

Many students with visual impairment complain that in science class, they just sit and listen while everyone else actively participates in the activities. However, they can become active participants if accommodations are made. This document explains one type of science lesson accommodation, tactile materials featuring the parts of a science system. Tactile materials for teaching space science concepts have been developed for elementary and middle school students and field-tested at a summer camp for students with vision impairment (Rule, 2011). Tactile materials similar to those showcased in this document have been used with great success by teachers with students who had significant visual impairments (Rule, Stefanich, Boody, & Peiffer, 2011).

An additional benefit of these tactile materials was that other students in the class who did not have vision impairments increased their learning when they used the materials. The colorful, highly touchable materials held their attention more than a flat diagram. Many students enjoyed running their fingers over the material as they reviewed the parts of the science system. Students also enjoyed creating tactile diagrams, learning the locations and names of parts as they worked.

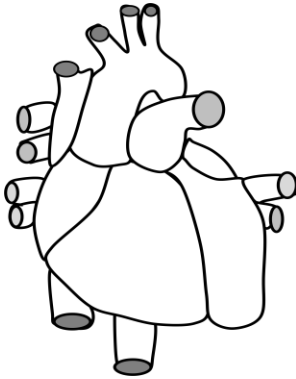
This document explains the procedure for making a tactile science diagram and then offers challenging critical thinking and creative thinking activities to follow the activity. Diagrams for eight different topics are featured.

This work supports the Universal Design for Learning (UDL) framework (Smith, 2012) that upholds equal learning opportunities for students from a diverse group regardless of their gender, age, race, disabilities, and more. The tactile diagrams provide accommodations for students with visual impairment and effective visual examples for all students. Additionally, the tactile nature of the diagrams assists students with attention deficits by providing a touchable resource for holding their attention as they learn the components of a science system.

How to Make a Tactile Diagram

This useful type of tactile teaching material consists of a diagram of the parts of a science system mounted on heavy cardboard. Each part is represented with glued-on materials that feel different to the touch. A key is provided with Braille labeling so that a student with vision impairment may be able to determine the parts he or she is touching.

First, teachers should choose a concept which can be illustrated using a simple and clear diagram such as the human heart pictured below:



Importing an image into PowerPoint and tracing each part is a useful way to create a diagram at the level of complexity desired. The image can be enlarged to the optimal size.

Second, create a key for the diagram that will later be labeled with a Braille label maker. Labels for students without visual impairment can easily be added in PowerPoint. After printing the diagram on cardstock paper, glue it securely to cardboard with white craft glue. Mat board, the colored cardboard used for framing pictures, works well. Then fill each part of the diagram with a different tactile material. See suggested materials in the table below. Use plenty of glue to hold the items in place. Each part of the diagram must have a distinct feel to it. If the texture is too similar to another section, the student with visual impairment may not be able to distinguish the sections from each other.

The key should be filled with tactile materials that correspond to the labeled parts. Once the diagram is dry, touch the diagram to make sure that all glued pieces are secure; add more glue if needed.

Tactile Items for Texturing the Diagrams

Glitter	Sandpaper	Felt	Sequins
Slick	Plastic	Shredded	Straws
Materials	granules	paper	Twigs
Chenille	Textured	Gravel or	Yarn or
sticks	fabric	pebbles	string
Foam	Popsicle	Styrofoam	Seeds
shapes	sticks	shapes	Rice
Twine	Beads	Rope	Buttons

Next Generation Science Standards

The Next Generation Science Standards (Achieve Inc., 2013) apply to the tactile diagrams, topics, the critical thinking exercises, and creative thinking activities throughout this paper.

In a number of the standards, students are expected to develop a model to provide evidence of their understanding. For students with visual impairment, a tactile model needs to be provided. The life science standards serve several of the topics. One could use the model of the parts of a flower to help a student become aware of how bees would take the pollen and pollinate other flowers (Standard 2-LS2-2). The plant cell model could be used “to describe the function of a cell as a whole and ways parts of cells contribute to the function” (Standard MS-LS1-2). Standard ML-LS1-3 gives us “Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells” to show how the various parts of an ear function as a whole to hear. The insect has parts that all insects have, providing evidence that “animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms” (Standard 3-LS3-1). The beaver’s habitat illustrates how “some organisms can survive well” in a particular habitat (Standard 3-LS4-3).

The earth science standards apply to the volcano and the sun activities. The parts of a volcano serve as a method for describing one pattern of the Earth’s features (Standard 4-ESS2-2). One might expand and consider “solutions to reduce the impacts of natural Earth processes on humans” (Standard 4-ESS3-2). Standard 5-ESS1-1 addresses the statement that “apparent brightness of the sun compared to other stars is due to their relative distances from the Earth.”

Finally, the physical science standard of applying “scientific ideas to design, test, and refine a device that converts energy from one form to another” (Standard 4-PS3-4) is associated with the activities for hydroelectric dams. Not only is the power of moving water converted into electricity, but problems associated with such dams are significant to humans and the environment.

The Edward de Bono Thinking Skills

In addition to supporting students with visual impairment through use of tactile materials, it is also important to engage students in critical thinking skills. Edward de Bono's CoRT (Cognitive Research Trust) thinking skills model (2000) consists of a framework of six sets of thinking skills. The first of these ideas is the *Breadth* set of ten foundational thinking skills. This set assists students in generating a wide range of ideas from many perspectives. Thinking skills in the Breadth set (with the abbreviations or key words in parentheses) include: rating aspects of ideas as plus, minus, or interesting (PMI); considering all the factors involved in a situation (CAF); determining a set of rules (RULES); identifying the consequences and sequels of an event (C&S); recognizing the aims, goals, and objectives of an action (AGO); planning an activity (PLANNING); determining first important priorities (FIP); generating alternatives, possibilities, and choices (APC); using several of the CoRT Breadth thinking skills to help in making a decision (DECISION); and collecting other people’s views of the situation (OPV).

De Bono believes that thinking skills can be learned and further developed through practice. Most problems have a strong perceptual component to them, causing people to jump to conclusions if they do not take time to examine the issues carefully. The CoRT Breadth thinking skills help thinkers

examine a problem or topic from many perspectives. Each science topic that had been addressed through a tactile diagram analyzing the system parts is again explored here through one of de Bono's thinking skills to sharpen critical thinking skills.

Creative Thinking Skills

We live in a world that is changing faster than ever before and facing unprecedented challenges. These challenges require innovative ideas and approaches. Because of pressure from meeting standards, teachers are using more standardized curricula and less creative approaches with their students. Students with disabilities are typically a subset of students who receive the least amount of creative opportunities in school even though using creative techniques has been shown to improve student achievement in school (Cornett, 2011). In this document, we provide creative thinking skill activities that can follow the explorations of tactile diagrams.

Several creative thinking skills are addressed by these lessons. Making a model in a new medium such as art, crafts, food, landscape arrangement, decorated clothing, quilt, or mosaic requires the learner to translate learning to a new domain. Model-making allows the student to notice different aspects of the system or object and consider them from new perspectives. A transformation also requires change. Figural transformations are simple geometric shapes or squiggles to which a student adds lines or shading to make a new picture. Recycled items can be transformed into new objects or scenes through creative repurposing. Similes and analogies are ways to make connections between different domains, allowing the student to identify defining characteristics of objects or situations. Humor requires a unique view of situations; it may be expressed in creative writing, jokes, or cartoons. Translating a topic into a song or poem is a creative way to allow student to practice new concepts. Creative writing that predicts the future or addresses the past includes science fiction, horror, disaster, or fantasy. Topics may be dramatized through pantomime, skits, or dance. Symbolic artwork can express students' emotional reactions to the topic. Finally, games are effective ways for students to envision a space in which science concepts are practiced through fantasy.

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The Tactile Diagrams, Critical Thinking Activities, and Creative Thinking Activities

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Parts of a Flower Tactile Diagram

(Diagram adapted from Science Kids, 2014)



Critical Thinking Activity

Created by: Jolene K. Teske

Prioritizing Choice of Flowers for a Celebration

This activity makes use of Edward de Bono's thinking skill called First Important Priorities (FIP). This skill asks students to determine factors that lead them to assign greater importance or priority to events or objects.

Instructions: Determine the factors for type of flowers to be used at a celebration. Prioritize them. Consider silk, plastic, paper, ceramic, and real, as well as variables like cost, appearance, reusability, fragrance, and others.

Sample Response

Cost is of primary importance to me; it's important to be fiscally responsible. In terms of cost, paper would be the first choice because it is inexpensive, and I could make my own flowers. Plastic would be next, and then silk, real, or ceramic.

Beyond initial cost, the possibility of reusability is very important: we must do our best to conserve resources to help the environment. Although paper would be least expensive, it would not be durable. There would be no possibility of reusing the flowers as they would be almost as fragile as real flowers; however, they could be recycled. Plastic, ceramic, or silk flowers could be used again. Real flowers, of course, could not.

I do want the flowers to look realistic and pretty. This is a very subjective area. Some types are definitely more realistic than others. Paper ones are not realistic at all. Plastic and ceramic flowers aren't very realistic either, though sometimes plastic can be surprising. Silk flowers are by far the most realistic; they look the most like real flowers.

I don't care about enhancing the smell. This is a non-issue. By comparing the variables, I will definitely want to have silk flowers. They are more economical than real, they are reusable, and they are the most realistic.

Creative Thinking Activity

Created by: Jolene K. Teske

Landscape Drawing of Flower Garden

Making a drawing that describes the arrangement of flower types in a garden involves many creative thinking skills. First, it requires a strong imagination to envision and plan a

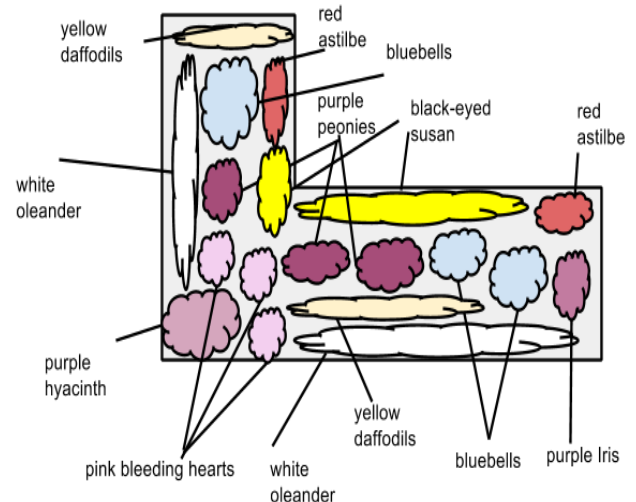
garden that does not yet exist. Spatial thinking is involved in transforming a three-dimensional flower display into a two-dimensional drawing. Artistic sense of balance is required to strategically place different colors and heights of flowers in the garden.

Directions: Interview residents at a nursing home to discover their favorite flowers. Create a landscape drawing for a flowerbed to be planted on the property of the nursing home. Collect donations (or sell plants), buy the selected flowers, and create the flowerbed.

Sample Response

I interviewed nine residents at our local nursing home and talked with the manager of the home to see where a flower bed could be planted. The northwest corner of the building seemed like the most appropriate, so we determined that an "L-shaped" bed would be best. After collecting the names of residents' favorite flowers, I created the following diagram to represent the flower bed. I tried to make it aesthetically pleasing with the arrangement of sizes, shapes, and colors.

Visually impaired students could interview residents and make notes on their favorite flowers. They would simply need a modification for the diagram. Using tactile materials with felt to represent the different sizes, shapes, and colors of the flowers as well as the flower bed, they would be able to create a diagram layout.

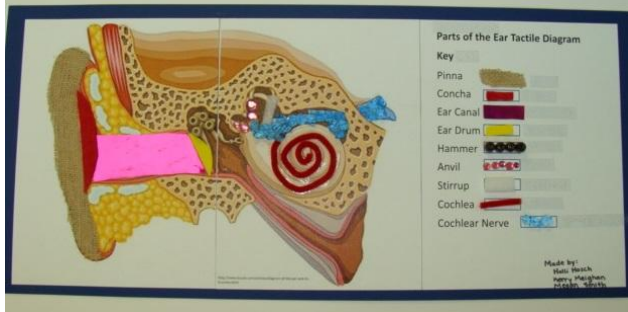


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Parts of the Ear Tactile Diagram

(Diagram adapted from New York Otolaryngology Group, 2004-2014)



Critical Thinking Activity

Created by: Phyllis Gray

Rules for Maintaining Good Hearing

The ear is a delicate organ. Serious damage to the ears can leave a person partially or completely deaf. In this exercise, students conduct research to learn more about the parts of the ear, typical ear health problems, and how these can be avoided.

Every situation in life has rules that should be followed. The Edward de Bono thinking skills include the skill of determining a set of important rules for a situation. In this activity, students will determine a set of rules for others to follow to maintain good ear health and hearing.

Allow students to pair up for this activity. Give the students time to examine and discuss the tactile diagram of the ear. Then have them research ear problems and how to maintain ear health. Below are two sample sets of rules. Students may generate rules for cleaning the ears or for avoiding damage from loud noises or music.

Rules for avoiding children's biggest problem of ear infections:

Parents should teach proper nose-blowing technique.

Keep your children away from people who smoke.

Be careful with bottle-feeding and avoid giving milk or formula to a baby who is lying on his or her back.

Rules for avoiding adult's biggest problem of swimmer's ear:

Avoid swimming in dirty water where there will be more bacteria.

Don't let the water remain in your ear.

Use a swimming cap to keep the water out.

Don't poke around in your outer ears with anything.

Exercise produces a certain protein, which may fortify the fragile hair cells in the inner ear that detect sound waves.

Avoid loud noises such as music or industrial machinery.

Wear ear plugs when using loud machinery around the house.

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Creative Thinking Activity

Created by: Phyllis Gray

Predicting a Creative Story Ending

Predicting an interesting story ending is a creative thinking skill that requires imagination. Stories that predict interesting science fiction, horror, disaster, or fantasy future events related to the topic call upon many creative skills such as generating a lot of ideas and adding details to make them better.

In this activity, students need to create an ending for the story "Makisha and Juanita go to the Science Museum" that predicts how Makisha and Juanita escape from the science museum ear display. Partner a visually impaired student with another student for this activity.

First, have the students become familiar with the diagram of the ear. Then, the students trace the path of sound through the ear.

Story Starter: Makisha and Juanita go to the Science Museum

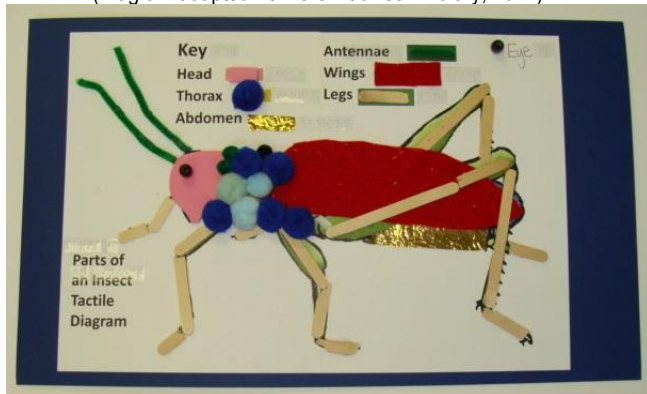
Makisha and Juanita did not realize that they were taller now than when they were in third grade, until Juanita bumped her head on the rough feeling pinna of the outer ear. They got down on all-fours and began to crawl through the ear. Once on their hands and knees, they felt their way past the pinna and the concha and entered the ear canal which felt slick and cool to the touch. Makisha, who had taken the lead, felt her head bump into something that moved when she pushed into it. She turned to tell Juanita, "I hit the ear drum." Juanita replied, "Put your hand out and find the hole." Makisha searched for the hole and found it and crawled through the hole. Once on the other side there was enough space so that she could stand up. She helped Juanita get through the hole and stand up.

Sample Ending: "Listen," Juanita said to Makisha, because they could hear voices outside the ear. "The museum people have returned," whispered Makisha. "Let's call for help to get us out of here," Juanita told her. "We'll get into trouble", said Makisha. "This is scary", said Juanita and she started to scream, "Help, help!" Makisha joined her and called, "We're in the ear!" One of the museum people heard them and lifted the top off of the ear to rescue the girls. Their teacher did not scold them because they looked so frightened sitting in the museum director's office. He just chuckled and said, "Let this be a lesson to you: "Keep out" means *keep out!*"

Have students predict another way that Makisha and Juanita get out of the ear. Then they should share with the class their version of how Makisha and Juanita escape from the ear exhibit.

Parts of an Insect Tactile Diagram

(Diagram adapted from the Robinson Library, 2014)



Critical Thinking Activity Created by: Latisha L. Smith

Planning a Bug Terrarium

Planning is an important de Bono critical thinking skill that requires a person to think logically and step-by-step. In this activity, students develop a plan for creating an inexpensive bug terrarium. Students should indicate what materials and equipment are needed. They should determine the steps that need to be taken to create an appropriate environment for insects of their choice. Include in the plan how to ensure survival of the insects in the terrarium. At the end of the plan, identify problems that might be encountered when creating and maintaining a terrarium, and then make changes to the plan to solve these problems, thereby improving the plan.

This project can be adapted for students with visual impairment by providing verbal and Braille instructions. Pair the student with a partner to design the terrarium. The student with visual impairment can be actively involved in deciding how to design the terrarium including selecting the insects, listening to verbal guidelines on how to make a terrarium, and assisting with a plan for each step of the process. He or she can also participate in the development of instructions to ensure the survival of the insects in addition to the identification of problems that could be related to creating and maintaining a terrarium.

Example Plan for Praying Mantis

Materials and Equipment: a praying mantis; terrarium usually made of plastic with a lid [a fiberglass window screen mesh lid or a rectangle of cloth taped to the edges will work; plastic wrap or glass lids are not recommended due to the odor that results from lack of ventilation]; spoon or a mister for water; sturdy twig with branches that is stable enough for the praying mantis to stand on.

- 1) Locate a clear plastic container to use as a terrarium for the praying mantis. A large container, up to 10 x 20 inches, is best. Locate a fiberglass window screen mesh lid for the top of the container.
- 2) In summer, mantises are usually up high on outside walls or porches. To catch a mantis, hold your hand above and in front of it or place a jar above it for the insect to step into. They are easy to catch if you move slowly and gently.

- 3) Locate a twig that is sturdy and has branches on it. Place it in the terrarium for the mantis to climb on. Keep the floor of the terrarium bare, with the exception of the twig.
- 4) Once you have placed the praying mantis in the terrarium, you can give it water in one of two ways. One way is to offer water using a spoon every day or spray droplets with a mister.
- 5) Be sure to feed the praying mantis by placing crickets, moths, and other live insects in the terrarium.

Potential problems include:

If insects are not readily accessible due to location or season of the year how could you move forward with a terrarium? Suggestion: Research online to see where insects might be purchased and mailed to you. Praying mantises, for instance, can be purchased from the Carolina Biological Supply Company.

Do the insects that you selected require a special diet? If so, what is needed and how would you access it? If the food source was not available in the immediate environment, a call or visit to a local pet supply store might be an option. For the praying mantis, live crickets could be purchased at a pet shop.

Are there watering and feeding recommendations that need to be followed for certain insects? If a ladybug is the insect of choice do not use a water dish because the ladybug could drown. It is recommended that a wet paper towel or cotton ball is placed in the container instead. A ladybug needs to be fed every day because it can eat up to 100 aphids per day; however, can survive on a few each day. Keep in mind the volume of food one ladybug eats when deciding how many to place in the container.

If you have one or more types of insects, will some of them prey on others? If so, what combinations should be avoided? Examples of insects that prey on other insects include the praying mantis, walking sticks, antlions, and ladybugs, to name a few.

If your terrarium is temporary, are there special steps that will need to be considered to reintroduce the insects back into their environment? If you have an antlion you may think it has disappeared in the sand home you have created for it. You'll need to sift through the sand to find a silken ball that is coated with sand. Place it in the sand outside so when the adult comes out it has access to a mate and can lay eggs.

Source:

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Creative Thinking Activity

Created by: Latisha L. Smith

Insect Diorama

Making a diorama that is visually appealing is a creative activity that requires the student to imagine a scene and then create it through making crafts and arranging items in a pleasing way. Students should conduct research on an insect of interest. After doing so, the student creates a diorama to share the research findings using pictures, objects, facts, and creative materials of choice. Include the following information: insect name, scientific classification, a visual representation, history, a minimum of five interesting facts, habitat, and how the insect is useful or harmful to humans.

This activity can be adapted for visually impaired students by providing instructions for the student verbally, in Braille, or in word processed form that can be read with a screen reader. Pair the student with a partner to create the diorama. Allow the student and his or her partner time to make a plan for constructing the diorama, particularly what materials will be used for construction. Allow the student choice in deciding materials to use and parts for which he or she is responsible.

Example

Insect: Cricket

Scientific Name: Gryllidae

Classification: Kingdom – Animalia, Phylum – Arthropoda, Class – Insecta, Order – Orthoptera, Superfamily – Grylloidea, Family – Gryllidae

What the insect looks like: Flattened body with long antennae on head, approximately one inch in length, looks similar to a grasshopper, has excellent vision and because of compound eyes can see in many different directions at once, has small wings but is unable to fly, and is usually black but can be red, brown, or green.

History: Part of folklore and mythology in many cultures.

Brazil - the singing of crickets is believed to be a sign of impending rains

Barbados - it is believed that a loud cricket means money is coming in

Asia - believed to bring good luck, they are often kept in cages as house pets.

Other beliefs - crickets chirps can tell the outside temperature

Five Facts:

- 1) Over 900 species of crickets worldwide
- 2) Crickets in the wild have a lifespan of less than a year
- 3) Some species are known to bite humans due to their powerful jaws
- 4) Only male crickets chirp in order to attract a female mate. When they rub their wings together the sound creating action is termed as stridulation
- 5) Their ears are located on the knees of their front legs

Habitat: Found in North America and throughout other parts of the world, during summer months often found in fields, beneath rocks, or under yard debris, and can survive in almost any type of environment.

Useful or harmful to humans

Useful: Assist in maintaining the balance of the ecosystem by breaking down plant material, renewing soil minerals and serve as an important source of food for other animals.

Harmful: Can injure seedlings and a large number of crickets can be very destructive to crops and gardens.



Cricket Diorama Front



Cricket Diorama Back

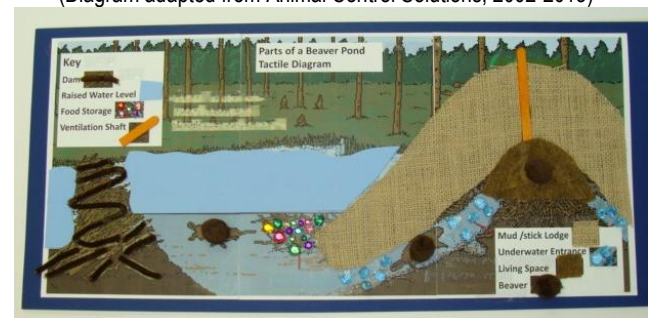
Sources:

Burande, Abhay. (2012, November 1). *Facts about crickets*. Retrieved from <http://www.buzzle.com/articles/facts-about-cricket-insect.html>

Bugfacts.net. (2008-2014). *Cricket*. Retrieved September 29, 2014, from <http://www.bugfacts.net/cricket.php>

Parts of a Beaver Habitat Tactile Diagram

(Diagram adapted from Animal Control Solutions, 2002-2013)



Critical Thinking Activity

Created by: Courtney K. Clausen

Beaver Habitats Benefit the Environment

The beaver habitat critical thinking activity involves application of de Bono's "Consequence and Sequel." Ask students to research information and list different positive consequences and sequels of beaver activity in an area.

Students should find both immediate and long term effects of flooding through beaver dams such as the creation of diverse animal habitats through rising water levels, and rejuvenation of drought laden lands through creation of small bodies of water and soil enriched by flood sediments.

Ask students to generate answers to the consequence and sequel prompt. Then, have students use the Internet to search for answers to the question and compare their lists of ideas with the facts found online. Online databases such as EBSCO or Encyclopedia Britannica can be used for a search limited to educational resources or your students can use some of the following websites and resources for the search:

- About beavers. (n.d.). *Beavers: wetlands & wildlife*. Retrieved from <http://www.beaversww.org/beavers-and-wetlands/about-beavers/>
- Animal Control Solutions.(2002-2013). Beaver trapping: Controlling beavers with traps. Retrieved from <http://www.animalcontrolsolutions.com/animals/beaver-trapping.html>
- Ferro, S. (2013). The odd way beavers impact climate change. *Popular Science*. Retrieved from <http://www.popsci.com/science/article/2013-07/what-do-beavers-have-do-climate-change>
- Hao, S. (2013). Engineers of the San Pedro River. *EARTHJUSTICE*. Retrieved from <http://earthjustice.org/blog/2013-june/engineers-of-the-san-pedro-river>
- Leave it to beavers. (2014). *Nature*. THIRTEEN Productions. Retrieved from <http://www.pbs.org/wnet/nature/episodes/leave-it-to-beavers/the-benefits-of-beavers/8865/>

There are many different answers that students will find when exploring these and other resources. Here is a list of some of the ways that beaver habitats clean the earth and provide habitats for other animals:

- Because of beaver activity, new ponds and meadows are created which can break down toxins and pesticides (Leave it to beavers, 2014)
- In arid environments, beavers' dams keep water on arid land and keep droughts from becoming an issue (Leave it to beavers, 2014)
- Beaver habitats act as, "... 'the earth's kidneys' to purify water....[this occurs] because several feet of silt collect upstream of older beaver dams, and toxics, such as pesticides, are broken down by microbes in the wetlands that beavers create" (About beavers, n.d.)
- The beavers' habitat creates a watery place for other animals to live including mammals, fish, turtles, frogs, birds, and ducks (About beavers, n.d.)
- Ferro (2013) explains, "When beaver populations relocate and abandon their dams, beaver meadows eventually dry up into grasslands, and the wood and organic matter buried there begins to decompose and release carbon dioxide".
- Beavers' dams help to pool water. The water then, "gradually seeps into the ground and recharges dwindling aquifers" (Hao, 2013).

Creative Thinking Activity

Created by: Courtney K. Clausen

Dramatizing Beaver Activities

Once students have become familiar with the different parts of a beaver habitat, a creative, dramatic play activity can help students to better understand how the beavers construct the

dams and build their habitats. This activity can be done with objects found around the classroom or outside.

Materials

Sticks, examples of supplies: Lincoln Logs, Tinker Toys, Popsicle sticks, branches, and leaves

Water, examples of supplies: blue construction paper, fabric, or blue plastic bags

Beavers, examples of supplies: clip art or jpeg images of beavers, beaver plastic toys, or beaver stuffed animals

Resources for beaver images labeled for reuse include:

- born1945. (2012). Beaver Teeth. Retrieved from <https://www.flickr.com/photos/12567713@N00/6954250603/>
- Steve. (2007). File:American Beaver.jpg. Retrieved from http://commons.wikimedia.org/wiki/File:American_Beaver.jpg
- Laszlo Ilyes. (2006). Castor Canadensis. Retrieved from http://en.wikipedia.org/wiki/Beaver#mediaviewer/File:Castor_canadensis.jpg

Scenes

Students may choose to brainstorm a list of scenes that they would like to create for acting out the building of the habitat or a list of scenes can also be given to the students to help them through the process.

Examples of scenes for this activity include:



A Beaver in the Woods



Beaver Cutting down a Tree



A Beaver Dam



A Beaver Lodge

For students with visual impairments and tactile learners, the pictures of the beavers can be cut out and covered with a brown fuzzy fabric so that students may feel where the beavers are in the different scenes. Below is a scene for which the beavers were cut out backed with beaver-shaped fuzzy fabric.

Students who would like to integrate technology into their dramatic scenes can take pictures of each of the scenes with slight changes and create a stop motion video. Once a

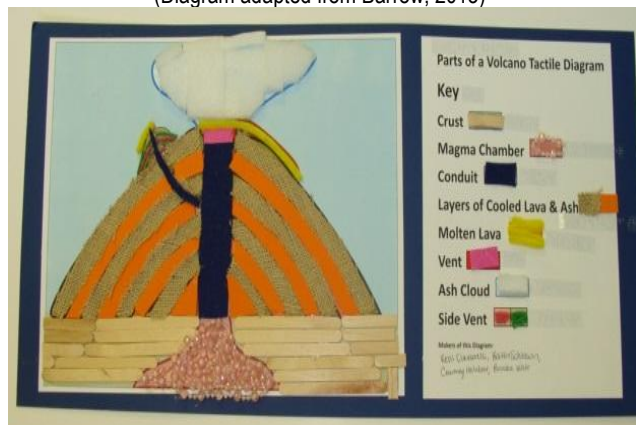
scene is created, students move the animals and background taking a picture each time to simulate that a beaver is cutting a tree down, assembling a dam, or building its shelter. Each time the scenery or animals are moved, the students take a picture and then use an application or software program such as iMovie to put all the images together into a short movie. If there are students with visual impairments in the class, these students can do the voice-overs or commentary for the video with the assistance of other students in the class.



Tactile Beaver Lodge

Parts of a Volcano Tactile Diagram

(Diagram adapted from Barrow, 2013)



Critical Thinking Activity

Created by: Mason A. Kuhn

Volcanoes' Effects on the Environment

The Edward de Bono thinking skill of Consider All Factors is explored in this activity. To implement this skill, determine as many factors as possible about a situation. Be sure to consider factors that are not obvious and those that result from considering the past and future. Also consider factors resulting from different people or environments.

To modify this activity for students with visual impairment, translate the writing on the cards (described and featured in the image below) into Braille or use a screen reader to speak the text of cards in a document.

In this activity, students are asked, *Are volcanoes good or bad for the environment?* They will have to construct an argument that supports their claim.

What Do You Know About a Volcano?

Did You Know?

volcanoes have a positive effect on the environment. They provide nutrients to the surrounding soil. Volcanic ash often contains minerals that are beneficial to plants, and if it is very fine ash it is able to break down quickly and get mixed into the soil.

Before the activity begins the teacher will create a stack of "What Do You Know About A Volcano?" cards (example above). Some of the cards list positive effects volcanoes have on the environment and some cards list negative outcomes of a volcanic eruption. Students will have the opportunity to read through the cards, and construct an argument either for or against volcanoes.

After students build their argument the class will have a debate and the teacher will act as a moderator of the discussion.

Sample Student Debate:

Student 1: I believe that volcanoes are good for the environment.

Student 2: Where is your evidence? They can't be good, look at all the destruction they create.

Student 1: Well, according to my "What do you know card," volcanoes provide important nutrients to the surrounding soil.

Student 2: Yeah, but my cards says long term exposure to volcanic fumes may aggravate existing respiratory problems in people.

Student 1: I guess maybe a volcanic eruption could be both good and bad.

Resources

Barrow, M. (2013). The mountain environment. Retrieved from <http://resources.woodlands-junior.kent.sch.uk/homework/mountains/volcanoparts.html>

Volcano World. (2014, June). Retrieved from <http://volcano.oregonstate.edu/what-are-some-good-things-volcanoes-do>.

Volcano World. (2014, June). Retrieved from <http://volcano.oregonstate.edu/how-do-volcanoes-affect-people>

Creative Thinking Activity

Created by: Mason A. Kuhn

Volcano Game

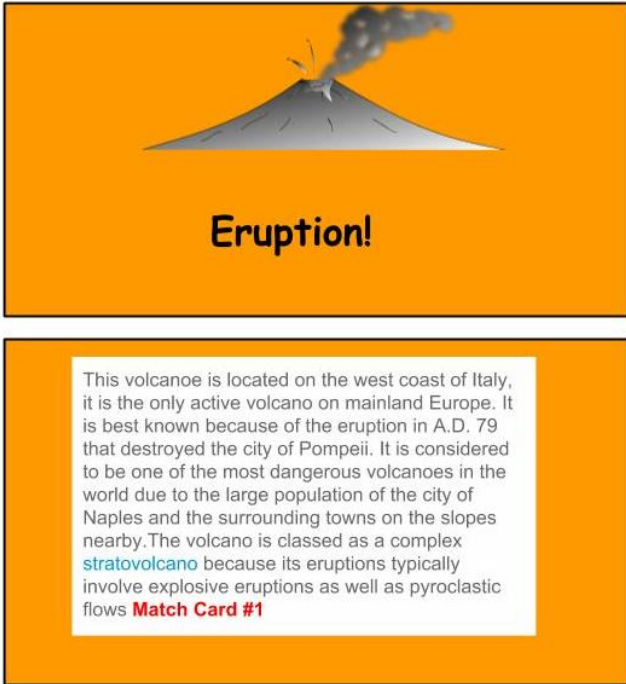
Creating a game or play set related to a topic requires creative thinking because the game maker uses his or her imagination to determine game components and interactions. In

this activity, students may work in small groups to develop a game about volcanoes.

Example Game

Eruption is a fun game for students learning about volcanoes. By playing this game, students will learn about nine of the biggest and most dangerous volcanoes studied by scientists. Students will learn about where the volcanoes are located, what type of volcano they are, and interesting facts that make the volcano unique.

Modifications for students with visual impairment include Braille for the flame cards and volcano cards and raised squares on the game board.



Front (top image) and Back (bottom image) of Example Eruption! Game Card



Front

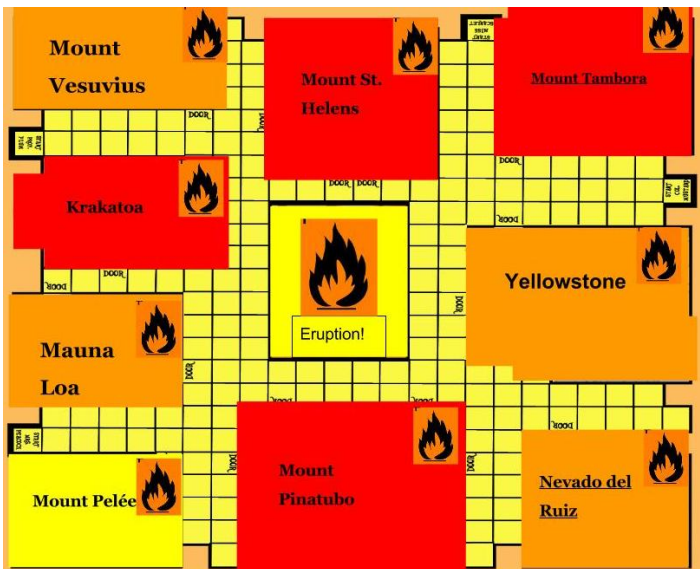


Back

Example Flame Card

Directions for Playing the Eruption! Game:

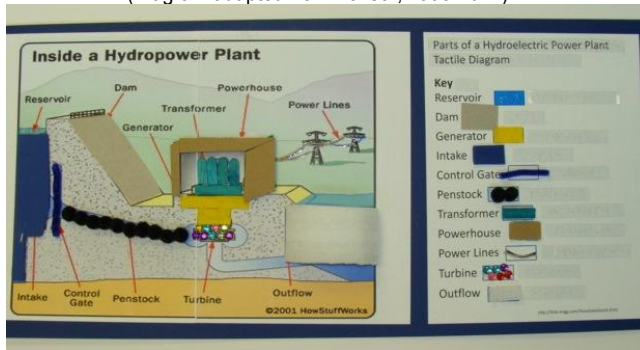
1. Players each select a game piece and place it in the center room labeled Eruption!
2. The first player chooses an Eruption! Card and reads about the volcano.
3. The player reads the information on the back of the card and decides which volcano he or she thinks matches the description on the game board. The player rolls a pair of dice and moves his/her game piece one square for every number displayed on the top of the dice. Players can only enter the room on the spots labeled "door."
4. If the first player rolls a number high enough to enter the room, he or she will look at the back of the flame card to determine if the number on the back matches the number on the bottom of the eruption card.
5. If the player rolls a number that is not high enough for him or her to reach a room, the next player rolls, selects an Eruption! Card, and repeats starting at step 2.
6. If the number on the back of the flame card matches the number on the back of the Eruption! Card, the player keeps the flame card and the next player takes a turn.
7. If the number on the back of the flame card does not match the number on the back of the Eruption! Card, the player puts the flame card back face down and does not show it to the other players. The player loses his/her turn and waits until it is his/her turn again to look in another room.
8. The game ends when all flame cards have been collected and the player with the most flame cards is the winner.



The Game Board for Eruption!

Hydroelectric Power Plant Tactile Diagram

(Diagram adapted from Bonsor, 1998-2014)



Critical Thinking Activity

Created by: Sukainah A. Alsubia

Diverse Views of Hydroelectric Dams

Edward de Bono thinking skills assist people in generating new ideas, analyzing issues, and thinking of solutions to problems. Hydroelectric power plants have been developed in countries all over the world to generate energy from the gravitational force of running water. Power generated from hydroelectric dams is the most widely used form of renewable energy. Various proponents have viewed the hydropower plant in different ways. The de Bono thinking skill of Other People's Views (OPV) was applied to building hydroelectric dams for power.

Several groups have drawn attention to problems associated with hydroelectric power plants. Ken Allinson (2013) noted that the initial cost of building a hydropower plant is large, which translates to using a lot of money in the construction of a plant occupying a significant land area. McKinney, Schoch and Yonavjak (2012) found that the construction of dams disrupts the immediate environment. For instance, people can be displaced from their homes when a reservoir formed behind a dam overflows and floods the land. The Conserve-Energy-Future group (2014) reminds us that dammed reservoirs can be a significant source of methane and carbon dioxide as flooded vegetation decomposes. Giving the example of marine fishing areas such as the Georges Bank of England, Moeller (2005) asserts that lack of oxygen due to the emissions from hydropower plants leads to destruction of sea life. Hareh Khemani (2011) stated that hydroelectric plants disrupt aquatic ecosystems. Fish and other water animals such as river otters or ducks may be swept into the penstock and turbines, where they die.

On the positive side, Johansson and Kriström (2011) asserted that a hydropower plant has a constant production and energy producing cost that is comparatively steady and does not change because of political or other conditions. Young and Loomis (2014) claimed that hydropower plants act as sources of clean energy, as they do not emit carbon dioxide that would pollute the environment as compared to fossil fuel energy. Jain and Singh (2003) noted that hydropower plants do not overuse water because after passing through the power plant, the water can still be utilized downstream.

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- Young, R. & Loomis, J. (2014). *Determining the Economic Value of Water Concepts and Methods*. Hoboken: Taylor and Francis.

Creative Thinking Activity

Created by: Sukainah A. Alsubia

Building a Model from Recycled Materials

Making a model is a creative thinking technique that forces the student to examine the geometry of various parts of a hydroelectric plant and how they interact. This activity is creative because it entails finding suitable materials to use and re-envisioning recycled items for a new purpose. Suggested materials are listed below.

Model: Build a model of the inside of a hydropower plant using recycled materials:

- 1- Reservoir- Have a rectangular box made of cardboard for the reservoir.
- 2- Dam- The dam is a reinforced wall on the front of the box. Use several layers of cardboard for this.
- 3- Intake-The intake of the dam can be a cardboard tube into which the water flows under the force of gravity.
- 4- Control gate- Cut a rectangular piece of cardboard and use it as the control gate.
- 5- Penstock- Use a plastic tube that would deliver water to the turbine.
- 6- Turbine- Use a plastic laundry detergent bottle lid with taped-on fins as the turbine.
- 7- Transformer- Attach another plastic lid on top of the turbine for this part.
- 8- Powerhouse- Use another cardboard box with a cutaway side to be the powerhouse.
- 9- Power lines- Aluminum foil can be used to make the power lines. Cut a long piece of the foil and twist tightly.
- 10- Outflow- Use another tube to deliver used water to the river below the dam.

Parts of a Plant Cell Tactile Diagram

(Diagram adapted from Armstrong, 2012)



Critical Thinking Activity

Created by: Audrey C. Rule

Consequence and Sequel within Plant Cells

The de Bono thinking skill of consequence and sequel asks students to use critical thinking skills to identify possible consequences or follow-on results to an event or situation. Consider the immediate effects, the short term consequences (1-5 years); the medium-term consequences (5-25 years); and the long-term effect (more than 25 years). For this plant cell activity, students are asked to research information and describe three "immediate" consequences or sequels that occur within plant cells.

Sample Student Response

1. Chromoplasts are colored plastids that contain pigments. When the chromoplasts make a flower look brightly-colored, bees are attracted and pollinate the flower so that it can make seeds and reproduce.
2. Chloroplasts contain chlorophyll and carotenoids. A plant cell with a lot of carotenoids may appear orange colored, for example, carrot, sweet potato, and tomato.
3. Specialized cell-to-cell communication pathways are called plasmodesmata and are pores in the cell wall through which the endoplasmic reticulum of adjacent cells are continuous. The endoplasmic reticulum manufactures and packages proteins. If a virus gets into a plant cell, it can use the endoplasmic reticulum to manufacture proteins for virus replication and then can travel throughout the plant via the plasmodesmata and pores in the cell walls.

Creative Thinking Activity

Created by: Audrey C. Rule

Analogy Applied to a Plant Cell System

Analogy causes the learner to make connections between two different domains. This comparison of systems allows the student to generate new perspectives and to play with the concepts.

Analogy: Think of a new analogy to the parts of a plant cell with at least 6 different analogous components and describe it. A sample student response is shown in the table below.

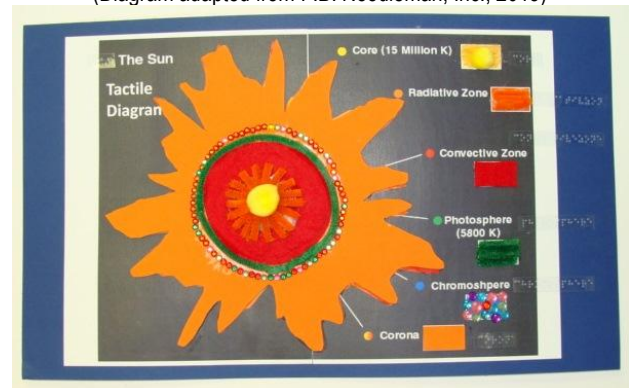
A plant cell is like a backyard swimming pool.	
1. The fence around the pool area	Cell wall protecting and giving structure
2. The sides of the vinyl above-ground pool and ladder	Cell membrane controlling entrance into the cell
3. The water in the pool	Cytoplasm supporting the organelles inside the cell
4. The filter that removes dead bugs	Lysosome organelle disposes of garbage
5. Chamber of a super-soaker squirt gun	Vacuole water storage
6. Solar cells that light the pool in the evening	Chloroplasts convert sunlight into energy and food
7. The list of rules posted	Nucleus of the cell controlling the functions
8. Stack of towels for <i>packaging</i> kids as they are exported from the pool	Golgi body packaging materials for export

Reference

Armstrong, W. P. (2012). Comparison of plant and animal cells. Retrieved from <http://waynesword.palomar.edu/lmexer1a.htm>

Parts of the Sun Tactile Diagram

(Diagram adapted from F.B. Noodleman, Inc., 2013)



Critical Thinking Activity:

Created by Maryam Ghayoorrad

Rating the Pluses, Minuses, and Interesting Aspects of Ultraviolet Radiation

Ultraviolet or UV radiation is part of the electromagnetic spectrum produced by the sun and other objects in space (NASA, 2013). Johann Ritter discovered ultraviolet radiation in 1801 (Diffey, 2002, p. 68). This radiation causes skin to tan or burn (NASA, 2010). These rays are used in some medical lasers or radiation therapies to cure cancer. UV is also used to disinfect wastewater. It is part of the spectrum of fluorescent lamps. If unprotected skin is exposed to UV radiation for a long time, it will become aged and may develop skin cancer. It's interesting that UV radiation is also a source for the body to create vitamin D. UV can cause damage to plastic and

polymer products and fade colors (The University of Waikato, 2008).

This activity utilizes one of the Edward de Bono thinking skills, Plus, Minus, Interesting (PMI). This activity is designed to increase students' understanding of ultraviolet (UV) radiation through critical thinking of its dangers and benefits. Students should read about the different parts of the sun and the electromagnetic spectrum that the sun generates.

Instructions: Research the positive and negative aspects of the ultraviolet radiation. Also note interesting aspects that are neither positive or negative, but are perhaps consequences of considering the information. Create lists of pluses, minuses, and interesting aspects.

Pluses

Provides vitamin D for the body
Used in curing cancer by radiation/laser
Used in disinfecting wastewater

Minuses

Causes sun burn
Can cause skin cancer
Ages skin
Destroys many polymer/ plastic products
Fades colors

Interesting Aspects

Generated by florescent lights
Ultraviolet light is beyond the visible spectrum
Even though this radiation is invisible, it's interesting that people have discovered it, and now use it in medicine

Creative Thinking Activity:
Created by Maryam Ghayoorrad

Word Play with Sun Idioms and Figural Transformations

This activity requires creative word play in which the learner plays with literal and figurative meanings of phrases containing the word "sun." Students should generate a list of phrases that include the word "sun" from memory, websites, or a dictionary. Learners should write a definition for each idiom in their own words. This activity also involves figural transformations. After compiling the list of idioms, transform given simple figures to produce pictures of the idioms by adding lines and shading. These figural transformations may be humorous in their approach to the literal or figurative meaning of each idiom.

Activity Directions:

Generate about eight different phrases or idioms that contain the word "sun," define each in your own words. Then, select four of them to draw by changing the given figures with added lines or shading. Interpret the phrases in clever, humorous or literal ways.

Sample Response

Make hay while the sun shines: Use an opportunity when it presents itself.

Go to bed with the sun: Going to sleep early when the sun is setting.

Happy is the bride that the sun shines on: Marrying on a sunny day brings the couple good luck.

Think the sun rises and sets on someone: Consider someone as most important.

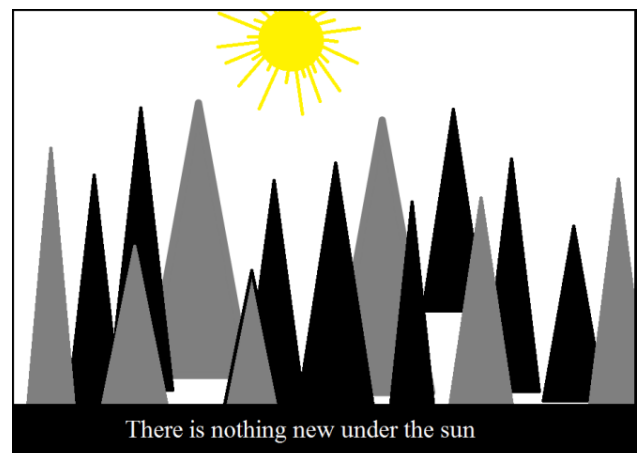
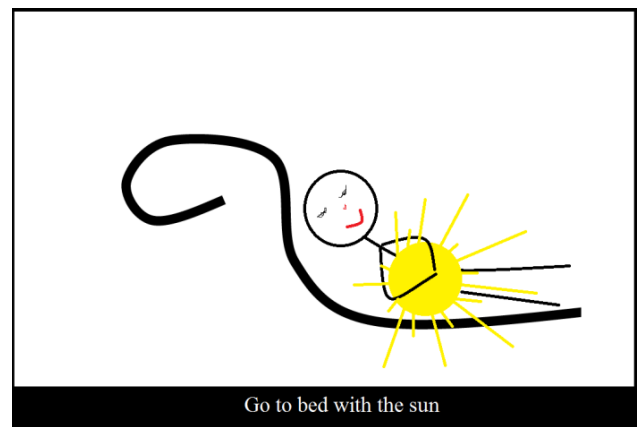
The Sun Belt: The geographic area of warm southern states.

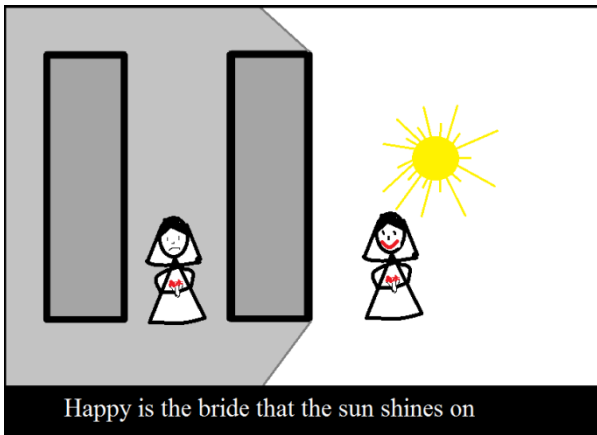
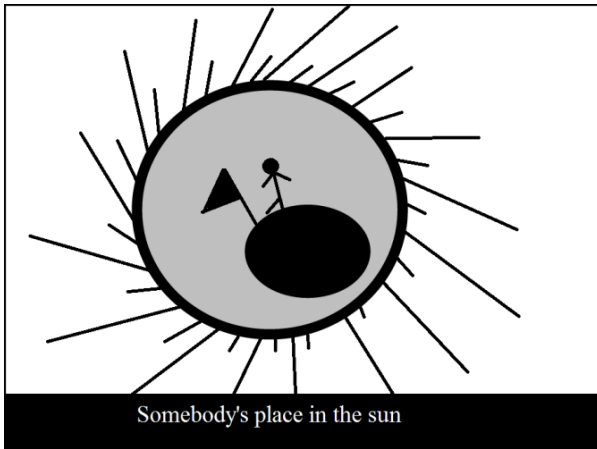
Somebody's place in the sun: A person's job or role in life makes them happy.

Under the sun: Located on Earth.

There is nothing new under the sun: Most ideas have been generated before.

Example figural transformations follow. In the first image, the curved line was the given figure; the student drew the sleeper and sun to represent "go to bed with the sun." In the second example, two gray triangles in the foreground were given; the learner transformed them into a forest to show "there is nothing new under the sun." The given figures for the third example were the large gray circle and the smaller black ellipse inside. The learner represented "somebody's place in the sun" with this drawing. The final figure had two gray rectangles as the given figures. The student used this drawing with two brides to represent "happy is the bride that the sun shines on."





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