Project Innovation
Creating Vertical Gardens

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Introduction

The purpose of this project is to promote innovation, sustainable water use, and the recycling of materials via the creation of vertical gardens.

To introduce the unit to students, there are a wide variety of resources teachers can access. The resources below represent a small selection of what could be demonstrated in a classroom.

a) Students form groups and research different types of gardens (e.g vertical gardens, traditional gardens, raised gardens), then compare and contrast via Venn Diagram. A class discussion can then take place with the whole group to highlight the major similarities and differences.
b) Highlight the disparity in the distribution of freshwater around the world by introducing two articles on water scarcity: The Burden of Thirst (by Tina Rosenberg) and Thirst (by Kristin Lewis and Tyler Riewer).
c) Discuss the urgency of our water situation by discussing global water shortages and highlight the drought conditions at Lake Mead.
d) Show two videos to the class: the first briefly summarizes Urban Farming while the second demonstrates what an established hanging vertical garden looks like. Discuss the increasing popularity and need for urban farming and relate it to widespread city growth and the movement of populations from rural to urban areas. For many urban residents without access to arable land, vertical gardens may be a solution to bringing healthy produce into the home.
e) Promote the benefits of organic gardening by linking it to the following:
    - improvement of personal well-being
    - establishing a connection to one's community
    - environmental benefits
f) Discuss water usage in the home by having students access Water Wiz, an online game that brings to attention the amounts of residential water used and wasted.

Everyday materials such as empty 2L pop bottles and clay pellets can be cleaned and re-used for large number of successive plantings.

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Materials used for SCCAO Project Innovation

Propagation Stage	For Hanging Garden
• propagation sheet (rock wool) Suggest using an alternative such as coconut fiber that is biodegradable and environmentally friendly.	Materials that are appropriate for your environment where you are hanging your gardens . • 3M hooks that can be easily used and removed • Eye hooks can be used if a permanent structure is desired This will allow gardens to stand securely when attached to the top of the pop bottle ‘tower’.

• propagation tray	

• seeds
  ○ a variety of types of lettuce seeds
  ○ various herbs
It is important that the plants chosen are low growing plants to that they fit into the pop bottles.	

• Green and Clean Hydroponic Plant Food (14-5-38) If you purchase a 1 kg container you will have ample for the entire project for a class of 30.	
• pH test liquid This will be used throughout the growing stage so 2 bottles of 15mL is required.	
Structure	
• Four, 2L clear pop bottles for each group	
• Clay pellets as a growing medium Could use coconut fiber, soil, perlite, ect...	
• 4 x 3cm cube of sponge for each group	
• String or wire to secure structure to wooden frame or window frame This will be modified as needed depending on the space you will create or have for your gardens.	
• Tin Foil to wrap the outside of the pop bottles to prevent sunlight exposure to roots and algae growth and to prevent evaporation (approximately two rolls) Could use white paint or tape to also do the same thing.	
• ⅛ inch drill bit OR • hammer and nail This is used to create holes in the bottle caps to allow water to flow from one bottle to the next. **Please ensure proper safety precautions and equipment is being used.** Please see STAO safety document for these guidelines.	

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Procedure

Depending on materials available, students can each build a garden, or they can work in pairs. If students are building individual gardens, it is helpful for them to work in pairs for the building process.

Planting Seeds: Before building the vertical gardens, students should decide what they will grow and plant three sets of seeds per garden in the rockwool tray. They will need at least two weeks to grow before they are ready to be transplanted into the vertical gardens.

Vertical Garden Placement: Before beginning this project, teachers will need to plan a location for the vertical gardens to hang. Each garden will need a minimum of 125cm of vertical space and 15cm of horizontal space in a sunny location. Hanging mediums will differ depending on the available space. If you have very small windows in your classroom, you can modify the gardens by removing one of the bottles.

Instructions for building one vertical garden: Adjustments can be made as necessary. See attachment for "Vertical Pop Bottle Garden Building Checklist". Students can use this checklist while building. During the building procedure all safety procedures must be followed. Consult your board's policies and procedures regarding safe use of tools and equipment, and recommended safety resources. A copy of the Science Teachers' Association of Ontario's "Safety in Elementary Science and Technology" reference guide is available here: http://stao.ca/res2/unifElemSafety/mobile.html.

1. Drill a 1 ⅛ " hole in the centre of the bottom of two empty 2L pop bottles. (This step should be completed by an adult.) Label these bottles A and B.
2. Use scissors to cut a rectangular hole (8cm wide, 6cm high) in the side of bottle A. The base of the rectangle should be about 5cm from the bottom of the bottle. Repeat with bottle B. (Hint: Teachers may need to start the cut with an X-acto knife or box cutter.)
3. Use scissors to cut the bottom 5cm off of a third bottle. Label this bottle C.
4. Use a one-hole punch to make three to five holes in bottle C approximately 2cm from the cut edge.
5. Use a ⅛" drill bit, or an X-acto knife or box cutter to make a small air hole near the top of the fourth bottle (D).
6. Use a hammer and nail, or ⅛" drill bit to punch/drill three to five holes in three bottle caps. (caps A, B, and C.)
7. Use an X-acto knife or box cutter to cut the top off of the fourth bottle cap (cap D); leave the cylindrical sides with the threads. (This step should be completed by an adult.)
8. Cut three, 3cm cubes from a sponge.
9. Compress the sponge cubes and insert them into bottle caps A, B, and C.

10. Build a double cap. The double cap is used to join the bottom bottle of the vertical garden to the reservoir. Click here for detailed pictures of the process. Place the top of cap A against the top of cap D. Use a small amount of hot glue around the edge where the caps meet, to attach them together and create a seal. Be sure the holes in the caps remain open. Place cap A on bottle A. Wrap waterproof tape around the outside of the caps to reinforce the seal. One edge of the tape should meet the edge of cap D, the tape can be wrapped around the neck of bottle A. Place bottle D onto cap D. (See attached photos for assistance.)
11. Insert the mouth of bottle C into the hole in the bottom of bottle B. This should be a tight fit.
12. Once the mouth of bottle C is through the hole, put cap C (with sponge) onto its bottle. You will need to reach through the hole in bottle B to do so. Once the cap is on bottle C, the two bottles should be attached together.
13. Repeat steps 11 and 12, inserting bottle B into bottle A.
14. Cut three 35cm x 15cm pieces of aluminum foil.
15. Wrap a piece of aluminum foil (shiny side out) around the top of 15cm of bottles A, B, and C. Tape it in place and secure the foil tightly against the neck of the bottle. (This will reduce sunlight hitting the moist pellets, discouraging evaporation and algae growth.)
16. Invert your bottles so bottle C in on top.
17. Use wire or string looped through the holes in bottle C to hang your garden.

Transplanting the seedlings:

1. Soak 1500 mL of clay pellets (per garden) in approximately 2L of water for an hour.
2. Once the clay pellets are wet, pour a small amount of clay pellets into bottle A, B and C. Place a cube of rockwool with the seedlings in the middle of the clay pellets.
3. Carefully place the remaining clay pellets around the cube of rockwool to hold it in place. Each bottle should contain approximately 500mL of clay pellets.

Maintaining the gardens:

18. In a large container, mix water with hydroponic plant food following the instructions on the container.
19. Carefully remove bottle D by holding onto cap D. Use a funnel to pour 1L of the water into bottle D.
20. Slowly pour the water from bottle D into bottle C. This water will filter through the vertical garden and collect in bottle D. Quickly reattach bottle D.
21. On a regular basis, detach bottle D and pour the collected water back into bottle C. Quickly reattach bottle D.

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Extensions for Vertical Gardens

The vertical garden Innovation Project is a great springboard for many other links to the Ontario Curriculum as well as Current Events and Environmental Stewardship.

1.Reduce Reuse Recycle

By being an active participant in collecting bottles, students are becoming an important part in their own reduce, reuse and recycle program. This is just one of the ways that our students can be exposed to real ways to be stewards of the Earth.

Reduce Reuse Recyle image courtesy of: https://www.zazzle.com/reduce+reuse+recycle+posters

2.Healthy Living

Each of our vertical gardens are creating a salad! This salad can be used as a link to the Healthy Living strand and the importance of good nutrition. This can also highlight the connection between poor nutrition and health problems such as obesity; linking what we eat, to what our body needs to function properly and stay healthy. Highlighting the vitamins and minerals that are found in 'greens' can extend to other nutrients found in carbohydrates, proteins and fats and then ultimately to a healthy child!

Garden Salad image courtesy of: https://www.oregoncc.org/file/474

3. Link to Community Groups

Many community groups can be contacted to extend this unit. We contacted Adoro Olive Oils and Vinegars, and they were willing to come into the class to allow students to sample various oils and vinegar combinations with lettuce and bread. This will allow many students to experience something they may not have had before and create excitement about the combinations they will use for their own salads they are growing.

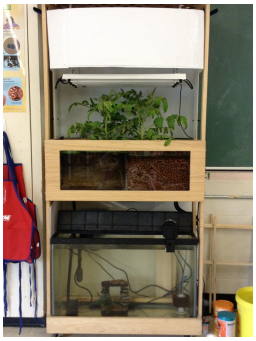
Oil and Vinegar image courtesy of:
http://www.keywordsuggests.com/kSA*xjBW3FguggCA5rQwkY13fHgaQCFxvzyBv%7CoVR62*SITGrKhpOrSjtTUv2yBGJmmfktMiM70NXyVp6aj0xA/

4. Inclusive for all incomes and living situations

Vertical gardens allow students to create a garden even when they do not have a yard available, such as those in an apartment complex. With the increasing cost of produce it can sometime inhibit families from buying these healthy options. Creating our vertical garden from recycled items, limited income families still have access to this as an option. Talking to the students about harvesting seeds from each of the plants would also allow this garden to be viable for years to come with no additional cost.

Balcony image courtesy of: http://unsafeproducts.com/household/apartment-balcony-railing/

5. Aquaponics



As a class, you could create and aquaponics integrated system using aquaculture (raising fish) and hydroponics (the soil-less growing of plants). By using fish wastes to 'feed' the plants and the plants used to filter the water, a closed and sustainable garden is being achieved. Please note that this can be as simple as floating a styrofoam plant raft in a regular aquarium, or trying

an experiment by hanging some vertical gardens over an aquarium and irrigating them with water from the fish tank to see if that will work just as well (water flows back into the tank as it leaves the bottom bottle).

6. Mathematics

Primary Data will be collected throughout the growth of the plants. pH and dissolved salts will be measured daily and these results will be graphed at the end of the project.