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Codemakers Operation Ocean Coding

Participants Perspective

- Today I learned how to create computer commands that accomplish a specific task by programming Ozobots to navigate the ocean floor.

Learning Goals

- Computers need specific commands in order to complete a task.
- There are multiple ways of writing a program and arriving at a solution.
- Robotics applications (such as remote operated vehicles, or ROVs) allow scientists to make observations and collect data from difficult to reach, or dangerous, locations such as the ocean floor.

Logistics

- Group size: Flexible
- Suggested length: 1 hour
- Age range: Grade 3-8 (adaptable), ozobots are recommended for ages 8+
- Material list:
  - Cambridge Bay Community Observatory Live Feeds
  - ONC Dance of the Cod Video
  - Ozobot Log Sheet (tracking participant use)
  - Ozobots Kit (1 Ozobot per group of 2-4 participants)
  - Arctic Ocean maps
  - Per group of 2-4 participants: Thick markers (e.g., black, red, blue, green); white paper; 50-cm string pieces
- Additional Information: NA

Safety Considerations

- Choking/ingestion hazard: Ozobots are small; review rules with participants prior to the activity and remind participants to not put science in their mouths.

Framework Connections

Toolsets	Skillsets	Mindsets
The basic building blocks that contribute to digital literacy.	**Competencies that help youth create value from technology and apply their knowledge, resources, or experiences.**	**Structured ways of thinking that prime youth to purposefully deploy their toolsets and skillsets and respond to evolving conditions.**
Knowledge Applications of robotics Ocean monitoring and surveying technology	**Digital Skills** Creating something useful from a simple input Programming a robot to efficiently accomplish a complex task	**Digital Intelligence** Leveraging technology in situations not accessible by humans - understanding processes
Resources Ozobots Maps of Arctic Ocean	**STEM Skills** Observation Data management Measurement Modelling	**Computational Thinking** Efficiency in task design Breaking down a path into individual instructions
Experiences Plotting an ocean survey track for a robot	**Essential Employability and Life Skills** Efficient use of resources Collaboration Problem solving	**Digital Action** Environmental monitoring Understanding human impacts Ideation to innovation

Nuts and Bolts

Advance Preparation

1. Charge the Ozobots - they will blink red/green when on low charge, blink green when on ready charge, and turn solid green when fully charged.
2. Split up the equipment for small group work (2-4 participants). Each group needs at least one Ozobot, markers (red, blue, green, black), and paper. Remove the paper with the codes from the Ozobot kit - participants need only the Ozobot and calibration card (the track is optional), since they will be making their own paths on paper.
3. Prepare a demo track to show the participants.
4. If doing the Group Puzzle Maze activity - prepare the puzzle pieces. To do this, arrange paper in a grid shape on the floor and draw black connecting lines between each page. Ensure there is at least one page for the start, and another for the end. You may also want to have multiple start locations, or just one (see Figure 1).

1. Show the Cambridge Bay Community Observatory live video feed (note: if unavailable due to technical difficulties, view the other community observatories). The ONC Dance of the Cod video is another resource to pique participant interest and set the stage for the lesson's exploration of deep-sea exploration and mapping - explain that this activity will mimic what the Cambridge Bay observatory shows. Sample questions for participants:
    a. What can you see or observe here?
    b. Why do you think this might be useful to scientists?
    c. Are there other groups of people that might be interested in this info - who?
    d. What kind of information might be helpful to get in deep-sea exploration?
    e. What might be some challenges with this type of work?

2. Have participants work in groups of 2-4. Use the Ozobots log sheet to track Ozobot(s) assigned to each group (note: each group needs at least one Ozobot).

3. Demonstrate how to use and calibrate the Ozobot (explain how calibration ensures that the Ozobot is working properly, and that sensors are measuring the colour data correctly):
    a. Press the ON button and place the Ozobot on a track (any).
    b. To calibrate, place the calibration card on a flat surface with black circle facing up.
    c. Press and hold the ON button until it flashes white, then place the Ozobot in the middle of the circle. It will flash colours, move forward, and turn off to signal that it is ready to use.

4. Give participants experimentation time with the Ozobots:
    a. Have them draw different coloured paths and report on their observations.
    b. Encourage experimentation with different colours, different stroke weights (thick versus thin lines), curvy lines, multiple lines or intersecting paths, and other variations. What do they observe? What conclusions can they make? (Note: Ozobots need straight lines of at least 5mm. When given two or more paths, Ozobots pick randomly where to go. Turns of less than 90 degrees can be difficult for Ozobots).

5. Explain that we use a special code language - colour - to communicate with Ozobots. Ask:
    a. How do the Ozobots know what to do? (Answer: different colour combinations and sequences)
    b. How do they "see" the colour combinations? (Answer: sensors)
    c. What kind of commands can you give Ozobots? (Answer: change speed, direction, timer, special moves, win/exit, counters - see Ozobots Color Codes Reference)

6. Support participants in creating a code in their track.
    a. Note: Colour codes need to have the following pattern: BLACK, <colour code>, BLACK. Sample colour codes:
        - <BLUE RED BLUE> = do a U-turn
        - <BLUE GREEN BLUE> = turbo speed
    b. Provide 1-2 examples to start - have participants make observations in order to report what the particular combination results in the Ozobot doing. Have

participants create their own codes and share with other groups in order to learn some of the Ozobots codes. Participants can record their findings.

7. Depending on age/ability of participants, see Modifications and Extensions for ideas on how to have groups experiment with colour codes on their tracks.

8. Once participants feel comfortable with the colour codes and operation of the Ozobots, they will apply this knowledge to map/travel along the Arctic Ocean Floor - similar to Ocean Networks Canada's ROVs (Remote Operated Vehicles).
    a. Provide each group with an Arctic Ocean map.
    b. Each track created must include the following parameters:
        - Start and Finish identified and used.
        - At least four colour codes.
        - Can not be one straight line - must be at least one turn.
        - The entire length of the course must be 50cm long (use the pre-measured string pieces to design the map course).
    c. Challenge participants to collect various samples at various locations throughout the Arctic Ocean - the task/sample can be based on the action of the Ozobot (e.g., full 360 spin = photo taken).
    d. See Modifications and Extensions for additional ideas on this challenge.

9. Once groups have completed their maps, give time for participants to test out each other's map tracks and share learnings with each other. At the end, collect Ozobots and use the Ozobots log sheet as reference.

Modifications and Extensions

- Discovering the colour codes can be discovery-based or provided to participants. This can also be made into a challenge, where participants have to create their own "Ozobot key" of instructions and see which group can create the most comprehensive key.
- The maps created (Step 8) can be made more challenging by providing more parameters. For example: must include three loops or intersections; the speed should change at four different locations; the Ozobots need to perform at least two dance moves before they finish the race; etc.). Participants can also challenge each other with such parameters.
- Participants can work in either direction - e.g., guessing the Ozobot actions based on the colour codes mapped out, or providing a list of steps/actions and then determining the proper colour codes. Groups can work together or challenge groups with such tasks.
- To make content more locally relevant, groups can be provided with maps from their community that they need to navigate - or create maps of their own with specific points marked for sampling (e.g., taking a photo, collect a water sample, etc. - with a unique Ozobot action assigned to each task).
- Provide extra time and more direct instruction as needed for support.

Assessment and Evaluation

- Check for understanding: How does this activity connect to the Community Observatory live video feed shown at the start (Step 1)? How are the Ozobots like real-world ROVs? What applications could you see ROVs used for in your community, and why?

Credits, Kudos, Shoutouts

This activity was developed in partnership with Ocean Networks Canada, and was inspired by Bits and Bytes and Extreme Oceans created by Actua Network Member Science Venture.

Terms of Use

Prior to using this activity or parts thereof, you agree and understand that:

- It is your responsibility to review all aspects of this activity and ensure safety measures are in place for the protection of all involved parties.
- Any safety precautions contained in the "Safety Considerations" section of this write-up are not intended as a complete list or to replace your own safety review process.
- Actua shall not be responsible or liable for any damage that may occur due to your use of this content.
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About Actua

Actua is Canada's leading science, technology, engineering and mathematics (STEM) youth outreach network representing a growing network of university and college based members. Each year 250,000 young Canadians in over 500 communities nationwide are inspired through hands-on educational workshops, camps and community outreach initiatives. Actua focuses on the engagement of underrepresented youth through specialized programs for Indigenous youth, girls and young women, at-risk youth and youth living in Northern and remote communities. For more information, please visit us online at www.actua.ca and on social media: Twitter, Facebook, Instagram and YouTube!

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Appendix A: Background Information

Introduction to Oceanography

Note: All images and figures in this appendix courtesy of www.oceannetworks.ca

Ocean Networks Canada (ONC), an initiative of the University of Victoria, develops, operates, and maintains cabled ocean observatory systems. The world-leading **NEPTUNE** and **VENUS** cabled observatories supply continuous power and Internet connectivity to a broad suite of subsea instruments from the coast to the deep sea, supporting research on complex ocean and earth processes. Instruments mounted on each observatory help scientists extend their senses and understand ocean processes by acting like their ears and eyes in the sea. From cameras to underwater microphones (hydrophones) to water quality sensors, the ocean is being explored 24/7 by scientists around the world.

Figure 1: Map of Ocean Networks Canada's cabled observatories.

Cambridge Bay Community Observatory Instruments

The following instruments work together to provide a moment-by-moment snapshot of the bay condition.

- **CTD – (Conductivity, Temperature, Depth instrument):** A standard oceanographic instrument that measures conductivity, temperature, and measures depth via pressure. This information can then be used to calculate values for salinity and sound velocity.

- **Hydrophone Array**: Hydrophones are like the "ears" of the ocean and collects acoustic (sound) data from both the natural environment (i.e. whales) and human induced noises (i.e. snowmobiles on ice).
- **Oxygen sensor**: Measures the amount of oxygen in the water
- **Fluorometer**: Measures how much Chlorophyll-a (like the green pigment in plants) is in the water. Chl-a increases during primary productivity, when tiny plants in the ocean bloom.
- **Camera**: The underwater camera is like the "eyes" of the ocean, taking video of the animals and surrounding environment.
- **Ice profiler**: Measures the ice draft, similar to how thick the ice is.
- **Shore-based time-lapse camera**: This camera is like the "eyes" in the sky. By seeing what is changing on land (i.e. amount of sunshine), can help scientists understand the conditions under the water.

ONC enables all sorts of cool research, from better understanding the melt and freeze-up of Arctic sea ice, to learning about the behaviours of animals on the seafloor, to providing early warning information about earthquakes and tsunamis. Ocean Networks Canada is currently looking at four major science themes that include ongoing experiments:

1. Understanding Human-Induced Change in the Northeast Pacific Ocean
2. Life in the Environments of the Northeast Pacific Ocean and Salish Sea
3. Interconnections among the Seafloor, Ocean and Atmosphere
4. Seafloor and Sediment in Motion

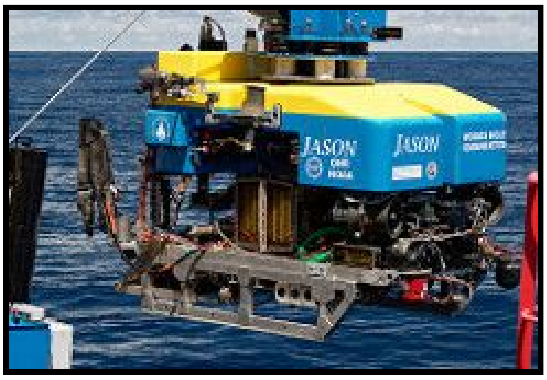
Remote Operated Vehicles (ROVs)

Most of the instruments attached to Ocean Networks Canada's underwater observatories are stationary. For example, the sensors that measure ocean temperature are secured to big platforms that sit on the seafloor and collect data from that one spot. This is helpful to get information from one spot over long periods of time. If we have these stationary sensors, why are robots necessary?

Using robots that can move around to collect data allows scientists to explore different areas and compare sites. Wally, the crawler, roams around the seafloor at Ocean Networks Canada's Barkley Canyon study site at approximately 900 meters in depth. Wally collects different types of data that we can use to study the ocean. Due to the depth, temperature and darkness at Barkley Canyon, it is challenging for humans to get to and explore the ecosystem on a regular basis, so ROVs are not only innovative technology, but hugely helpful!

Since Ocean Networks Canada's instruments range in depth from 23 metres to 2660 metres (on NEPTUNE / VENUS) maintenance on the observatories require the use of a Remotely Operated Vehicles (ROVs) to assist. ROVs are unmanned vehicles that are tethered to a ship via a cable that gives them power and streams live video. Approximately four ROV pilots aboard the ship control the

ROV's movements by watching screens of what the ROV is "seeing"—kind of like a real life video game. Pilots are very well trained and usually work 4–12 hour shifts. Since the deep sea is dark, it doesn't matter when the ROV is exploring underwater—1:00 pm is the same as 1:00 am—so ROV dives can run 24 hours a day. ROVs are equipped with two multi-function robotic arms, lights, and cameras. They are also quite large, weighing between 1–4 tonnes out of the water.



Apart from the instruments and the innovation it has taken to get instruments to function in the deep sea, a major component of Ocean Networks Canada is the fibre optic cable; without it, the system would not be able to collect real-time data or be powered from shore as efficiently. Being connected to the instruments via the internet also allows ONC's systems team to check in on instruments, make minor adjustments and keep things functioning smoothly. ONC has three sizes of cables on the observatories:

1. Large backbone cable that powers the "nodes" from shore
2. Medium cable that goes from the "nodes" to the platform
3. Small cable that powers each instrument from the platform

ONC's largest and deepest observatory, NEPTUNE, is configured in a circle. This is important because if one site goes "down" (i.e. loses power or is disrupted), the power can be rerouted in the other direction to keep the rest of the sites up and running. In this activity, we will be taking a look at how difficult it can be to re-route information, and how careful planning is necessary in designing networks.

The Cambridge Bay observatory is much smaller than the cabled observatories in British Columbia. However, it is just as innovative, as the engineers had to find ways to keep the instruments working in cold conditions and under ice. The observatory is only at about six meters in depth and is connected by the fibre optics cables to a shore station on the dock. The cable is run through a metal pipe so that the shifting ice does not break it. Although the air temperature in the Arctic can be extremely cold (up to -60 degrees C), the sea temperature, even under the ice is only about -2 degrees Celsius, so instruments at least have to be able to work below 0 degrees.

Figure 2: ONC's arctic observatories in Nunavut.

Suggested Career & Mentor Connections:

- Oceanographer
- Meteorologist
- Environmental Scientist
- Ice Monitor
- Virtual presentation from Ocean Networks Canada
- Local weather, climate, ocean or ice scientists
- Visit from an Elder or member of the Hunter and Trappers Association