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The Great GPS Scavenger Hunt

Andrea MacInnes and Sandra McEwan

Grade level: Grade 9.

Provincial curriculum links: Ontario.

Subject: Geography.

Keywords: Waypoint, route, multipath, weathering, mass wasting, sediment transportation, creep, slides, debris flow, geomorphology, geology.

Description

This lesson requires students to learn to use a GPS receiver as they learn about physical geography. Students will use GPS receivers to survey an open area (natural or disturbed ecosystems) and investigate the different species of plant populations, rock and land formations, and soil types either in the school grounds or in recreational areas in the local community. Students will examine the geologic and geomorphic formations and describe how water and wind erosion have shaped the landscape and helped further plant and animal succession.

Curriculum Framework

This lesson is linked directly to the learning expectations described in the Ontario Curriculum for Grade 9 Geography of Canada (CGC 1D). The learning expectations are also broadly applicable to other Canadian curricula.

Topic: Geography of Canada Strand: Methods of Geographic Inquiry Specific Lesson Goals:

- demonstrate an understanding of the technologies used in geographic inquiry (e.g., Geographic Information Systems (GIS), hypermedia);
- select and use appropriate methods for displaying geographic data.

Preparation

Preparation time: Time varies depending on the number of waypoints the teacher wishes to use in this investigation. (Teacher must locate each site, obtain latitude/longitude coordinates for each, then create a small marker or give students a clue to identify their first site).

Length of lesson: Approximately 180 minutes for class discussions and field trip.

Resources required:

Procedure

1. Before you begin the fieldwork, make sure you have completed the following tasks:
2. All your latitude and longitude coordinates are correct for each chosen location.
3. Include one letter of a "secret word" at each location. The secret word should pertain to this lesson, e.g.: "erosion", or "landscape", or "mapping", etc.
4. All your hidden coordinates are in good condition (i.e. dry and undamaged).
5. Each GPS receiver is set to your exact specifications.
6. Brainstorm with the class examples of geologic structures (pertinent to present unit), stream characteristics, soil types and vegetation found in a natural environment. Examples include: a meadow; a naturally regenerated woodlot/forest, an undisturbed ditch, the natural shoreline of a pond, lake or stream.
7. Define and discuss weathering. How does weathering affect the landscape and vegetation? Brainstorm with the class different types of weathering and their causes.
8. Physical weathering - the fragmentation of a larger rock into smaller pieces by mechanical processes. These processes include:
   (a) abrasion (erosion of a rock due to the impact of grains carried by wind, water, or ice)
   (b) fragmentation during downslope movement via rockfalls, landslides, etc.
   (c) frost wedging via the freeze/thaw cycle. thermal expansion
   (d) contraction via heating and cooling
   (e) Chemical weathering - breakdown of rock or mineral through reactions between rocks/minerals and atmospheric constituents such as water, oxygen, and carbon dioxide. The most common reactions include:
      i. Solution - molecules and elements in rocks and minerals dissolve directly into water
      ii. Oxidation and hydration - reaction between oxygen, water, and iron-bearing minerals that helps to break down minerals
      iii. Hydrolysis - a complex weathering reaction that forms clays, the primary constituent of soils.
9. Explain mass wasting (the downhill movement of soil and rock under the influence of gravity) and two of its key gravity-driven erosional processes: water and wind. Discuss with students the effects of water and wind on the landscape. These processes can occur quickly, such as a landslide, or slowly, such as the downslope movement induced by freeze/thaw cycles.

10. Review the importance of proper care for the GPS receivers. They are expensive pieces of equipment and are costly to repair or replace.

11. Divide students into small groups and distribute : a GPS receiver, a list of coordinates with clues, student worksheets.

12. Student groups should consist of no more than 6 members. Each student should be given a particular role in the group such as: group leader, equipment manager, data collector, identification coordinator, safety officer.

Special Task	**Function**
Group Leader	Responsible for overall performance of the group.
Equipment Manager	Prepares a list of the equipment, instructs others in its use and ensures that it is all returned undamaged.
Data Collector	Ensure that all data are recorded or drawn on the worksheets. Keeps track of scrambled letters.
Identification Coordinator	Maintains the "library" of identification materials and ensures that landforms, plant life, soil structure, etc, are properly identified.
Safety Officer	Ensures that the group stays together and that safety regulations are followed.

13. When students arrive at the site, each group will use their GPS receiver to navigate to each waypoint. The teacher will distribute the first waypoint to each group, as well as a "clue" to help students figure out what to draw and how to locate the second hidden waypoint. Ensure that the initial waypoints are all different to prevent more than one group traveling to a single location.

14. After reaching the first waypoint, students will quickly sketch the landform, indicate the vegetation in the immediate area and list all possible types of weathering they can see (e.g. cracks in rock caused by freeze-thaw; plants may be growing from seeds deposited in cracks by the wind).

15. Since the coordinates to reach each waypoint are hidden, the teacher must prepare them ahead of time. Waypoints can be hidden anywhere at the coordinate. For example, they can be placed in an envelope wrapped in a plastic baggie placed in a stone cairn; in a marked film canister; written on a thin piece of wood which is then attached to a tree (be careful not to damage the natural environment when hiding the coordinates). When hiding the waypoints, make sure the package is waterproof to eliminate the possibility of the clue being damaged or illegible. Students must search for the new waypoint, enter the latitude/longitude coordinates into their receiver and begin navigating to the second location. They also must record the "secret" letter to form the scrambled word at the end of the investigation. The letters from each of the waypoints will form a secret word of the day.

16. Before students leave a location, they MUST make sure that the coordinates are replaced EXACTLY as they were found to allow the remaining groups to complete the exercise.

17. A cache consisting of various "goodies" will be located at the teacher's position (the final latitude/longitude distributed to students). Once the students have completed the exercise, they must unscramble the code word. To collect the cache, students travel to the last waypoint and show the teacher their completed sheets and their unscrambled word.

Discussion and Questions

1. Which waypoint demonstrated the most marked example of weathering? What process was responsible for the weathering?

2. How is GPS useful in assessing environmental damage?

3. What are the difficulties of operation GPS equipment under large tree canopies or in large, high-density cities?

4. Each group may share their results with the class. Use whole-class discussions to summarize the effect of weathering on the landscape and highlight how the land has been shaped by different types of weathering. How can the effects of weathering be reduced?

5. After examining the day's findings, students will write a short report on a current issue surrounding the unscrambled code-word while incorporating the experiences of the day into the report.

Student Evaluation

- Completion of worksheets and quality of observations
- Observation
- Peer and self-evaluation

Enrichment and Extension Activities

- Create a map of the school boundaries using the GPS receiver. Once the route is created, download the information using GPS software such as Pathfinder. This route can be opened up in GIS (Geographic Information System) software such as ArcInfo or ArcView for further analysis (e.g. investigate the effects of weathering on the school building and around the school grounds).
- Study the usefulness of GPS in our society today. Making reference to technology, the flexibility of GIS, write a paper to illustrate how GIS and related technology can be used to assess the state of an ecosystem.

- Present findings to principal or school board as evidence to support the enhancement of GIS technology in schools.
- Routes created by students can be superimposed on an aerial photograph and incorporated into lessons focused on: urban geography or demography (if investigation was conducted in an urban landscape); the sustainability of forests/silviculture or agriculture (if investigation was conducted in a rural area).
- Geocaching has become a popular activity among GIS enthusiasts. Set up a Geocaching account and have students plant caches to be found by other GPS users. Ensure that the caches are NOT placed on private property.
- If the investigation was conducted on school property, students can explore a recreational area or a natural area to compare and contrast the different land formations, different tree/animal species and different types and effects of erosion on the landscape.

Educator Notes

- GPS stands for "global positioning system". This is a satellite navigation system which provides precise locational information based on data transmitted from a constellation of 24 satellites orbiting the earth. It provides specially coded satellite signals that can be processed in a GPS receiver, enabling the receiver to compute position, velocity and time.
- GPS was developed by the American military and was originally intended for military use only. The GPS system is still controlled by the United States Department of Defense.
- GPS signals are free to all. This means that no cost locational/navigational data is available to anyone with a receiver. GPS availability is worldwide, 24-hours per day, 365 days per year. Additionally, low entry cost means that user equipment can be relatively inexpensive, depending on how accurate the user requires their measurements to be.
- Uses for GPS are abundant. This technology can be used for recreational activities such as fishing, hiking, and geocaching as well as complex tasks such as navigation, surveying, mapping and vehicle tracking. Users of GPS technology can utilize any point as a reference to navigate to another point.

Setting Up the GPS Receiver

- Students should ensure that their position format is in hdddmm.mmm'
- Map datum should be set to WGS 84. Distance/Speed is metric. Elevation is in meters. Vertical speed is in meters/minute and depth is set to metric.
- The heading should be set to display Cardinal Letters and North Reference should be set to "True North"

- Make sure that the GPS mode for the receiver is set to "on". If the students are getting poor satellite reception, they should ensure that WAAS (Wide-Area Augmentation System) is enabled.
- Thoroughly investigate the school grounds/recreational space before the investigation to locate specific features/plant or animal species and obtain coordinates for each location. The number of locations and the distance between them depend on where the investigation is taking place. Spread the locations well apart to avoid groups interfering with each other.
- The total number of coordinates should be such that it will take students at least 2 hours to complete the worksheets. Ensure that the coordinates are skillfully "hidden" at each location. This adds to the fun of the day and prevents tampering.
- The location of each point to which students will navigate are stored in the GPS receiver. The teacher may enter the points in each receiver ahead of time, however, it may be beneficial for students to enter the points themselves. The GPS terminology students should be aware of are listed below:
  - **Waypoints** - points that are stored in the receiver.
  - **Route** - path created by traveling from one waypoint to another.
  - **Coordinate** - longitude/latitude values of each point.
  - **WAAS** - Wide-Area Augmentation System. It is a system of satellites and ground stations that provide GPS signal corrections to allow for better position accuracy. Enabling WAAS on a receiver improves accuracy by approximately 5 times (e.g. from an accuracy of 15 m to an accuracy of less than 3 m).
  - **Multipath** - caused when the GPS signal is reflected by some object or surface before being detected by the antenna on the receiver. The surface most prone to multipath is water, whereas sandy soil is the least. Multipath errors are more common in densely wooded areas due to the number of trees reflecting the satellite signal.
- Students should have prior knowledge of the following terms: composition of soil (minerals, organic substances, water, air), types of soil particles (silt, clay, sand, pebbles), types of streams or rivers (straight, braided, meandering), types of rocks (igneous, sedimentary, metamorphic), geologic formations (ridge), and major types of erosion (water, wind, chemical).
- If it is not possible to visit a park or large recreational area, a great place to conduct this investigation would be on a large college or university campus.
- This investigation can be conducted at any time during the school year. Given the fact that students will be outdoors for the duration of the investigation, it is preferable to do the fieldwork on warmer days before or after the snow melts.
- SAFETY NOTE: Consult your school board's policy regarding safety precautions for outdoor excursions and plan your trip accordingly. Be aware of any students with allergies to insect bites and plants and ensure they carry the required medications. Students should wash their hands after handling soil, plants and equipment. Encourage students to wear sunscreen and appropriate clothing (e.g. hat, long-sleeved

shirt) to minimize the damaging effects of sun exposure. Appropriate footwear is also necessary, particularly if the investigation is to be conducted in areas outside school property such as parks, wildlife preserves, woodlots, etc.

References

References

Investigating Terrestrial Ecosystems. Scarborough: Prentice Hall Canada, 1986.

For information on the operation of GPS equipment, visit: www.trimble.com

Worksheets

Student Worksheet

Date: _____

Group Members:_____

In this activity, you will use the GPS receiver to survey an open area and investigate the different types of weathering and study how they affect species of plant populations, rock and land formations and soil types. At each location, you will find a new coordinate and a secret letter. The new coordinate will lead you to your next location. Keep track of the secret letters: they form the "secret word" of the day, once they are unscrambled.

Your **FIRST** waypoint is: _____.

This is your starting location.

Your **FINAL** waypoint is: _____. Navigate to this location *AFTER* your worksheets are completed and you unscramble the "secret word".

Create a chart like this for each location you visit:

Coordinate #___		**Sketch of Area**
Secret Letter:		

Description of Weathering:

THE SECRET WORD IS : _____