SCIENCE NORTH SCIENCE NORD
SUDBURY, ONTARIO, CANADA

Biodiversity Algorithms	Grade 6 Understanding Life Systems

Lesson Plan

Coding Tool	Algorithms, pseudocode
Cross-curricular	Space, Art

Big Ideas

- Classification of the components within a diverse system is a beginning point for understanding the interrelationships among the components
- Grouping lifeforms into characteristic groups ('clades') is an algorithmic activity, consisting of a sequence of IF, THEN/ELSE statements.
- Algorithms can be expressed as pseudocode

Specific Expectations

2.3 use scientific inquiry/research skills to compare the characteristics of organisms within the plant or animal kingdoms

3.1 identify and describe the distinguishing characteristics of different groups of plants and animals (e.g., invertebrates have no spinal column; insects have three basic body parts; flowering plants produce flowers and fruits), and use these characteristics to further classify various kinds of plants and animals (e.g., invertebrates – arthropods – insects; vertebrates – mammals – primates; seed plants – flowering plants – grasses)

Description

In this lesson, students will write pseudocode to identify an organism based on its distinguishing characteristics.

Materials

- Writing implements (pen and paper or computer)

Computational Thinking Skills

- Algorithms
- Pseudocode
- Optional extension: block coding

Introduction

Swedish naturalist Carl Linnaeus (1707-1778) founded the modern biological science of Taxonomy by grouping creatures based on similar traits. In Linnaeus' system, any creature could be examined, and the question asked (for example) "Does it have a backbone?"; the answer "yes" would automatically classify the animal as a vertebrate. Modern classification of biodiversity has been altered somewhat from Linnaeus by our understanding of evolution, but the basic framework remains for examining a life form, and based on its gross characteristics, placing it in a kingdom, phylum, class, order, familiy and species.

This questioning ("Does the animal have X characteristic trait") is essentially an IF/THEN

statement, so the entire process of taxonomy can be thought of as a kind of algorithm.

Algorithms can be expressed visually (as the traditional 'tree of life' diagrams) or as pseudocode. There are many ways of writing pseudocode that resemble different programming languages, but the point is to write something that has the structure of code, but is simpler and more abstract than the actual program. For example, there are generally considered 2 'domains' of life: the Eukaryotes and the Prokaryotes, of which the main, characteristic difference is the presence of a nucleus in the cell (eukaryotes) or absence (prokaryotes).This pseudocode would tell them apart, by checking inside the cell of an organism for a nucleus:

```
IF(Organism's cell has nucleus)
   Organism belongs to domain: Eukaryote
ELSE
    Organism belongs to domain: Prokaryote
```

Now let us expand this algorithm to divide the Eukaryotes by kingdom:

```
IF(Organism's cell has nucleus)
   Organism belongs to domain: Eukaryote
    IF(Organism has cell walls)
       IF(Organism performs photosynthesis)
          Organism belongs to kingdom: Plants
       ELSE
          Organism belongs to Kingdom: Fungi
    ELSE
       Organism belongs to Kingdom: Animal
ELSE
    Organism belongs to domain: Prokaryote
```

(Notice here how indentation creates the structure of the pseudocode: If the statement in brackets is true, read down and in; if it is false, follow down until an ELSE is found in line with the un-true IF.)

Action

Within the basic framework of "write pseudocode to identify an organism" several different activities are possible:

- Assign each student or group of students a particular organism to research, defining its characteristic traits and writing pseudocode to distinguish it from its near relatives (eg. Pseudocode that would select the orca out of the family of whales)
- Assign each student or group of students a particular biome, and challenge them to write pseudocode that would identify as many organisms as possible that they can think of (or find via research) given their characteristic traits (found by research or inquiry.)
- This activity can be linked with both the space and art curriculum by having students create their own creatures, adapted to alien environments (the clouds of a gas giant planet like Jupiter, or the lightless oceans under the ice of Europa, for example) and creating algorithms to classify the creatures they create.

If you feel it fits your class better, rather than pseudocode, you can give the option of producing the taxemic sorting algorithms visually using a flowchart.

Consolidation/Extension

There are a few ways to extend this activity, which are not mutually exclusive:

- Assign students into ever-larger groups to combine their algorithms until the entire class's 'tree of life' pseudocode is linked.
    - To extend this further, you can assign groups to find 'gaps' and modify the algorithm to include missing creatures.
- If your class is very advanced in coding and has experience with block code like Scratch or another system, consider implementing the classification algorithm as an actual computer program.

Assessment

Simultaneously assess your students' pseudo-code (or flow chart) for understanding of the logical structure of the algorithm, and for understanding of the characteristic traits of creatures.

Additional Resources

https://www.linnean.org/learning/who-was-linnaeus
https://basicbiology.net/biology-101/taxonomy
https://www.vikingcodeschool.com/software-engineering-basics/what-is-pseudo-coding
https://www.code4example.com/pseudocode/pseudocode-examples
https://scratch.mit.edu/