Teaching Ecology Using Ecosystems, GPS, and GIS

Eriek Hansen
Science Posse
University of Wyoming

Building Teachable Units

1. Identify desired results (learning goals)
   - **Facilitate an understanding of ecology using ecosystems**
     - **Understand levels of diversity within ecosystems (spatial scale)**
     - **Understand the role of disturbance and succession (temporal scale)**
     - **Understand the roles of mapping, GPS, and GIS in ecological studies**

2. Determine evidence for learning (learning outcomes and assessment)
   Students will be able to compare and contrast different ecosystem types at multiple spatial and temporal scales

3. Plan learning experiences and instruction (activities)
   -Placed based learning: field trips to different ecosystems
   -Active learning: using a jigsaw approach to have students teach each other about ecosystems
   -Skills: GPS, mapping, and GIS

4. Align goals, activities, and assessments

Unit 1

Unit objective: Learn to operate GPS units for mapping ecosystem features
Unit sub-objective: Identify and map features on the schoolyard
Unit activity: Map schoolyard using points, lines, and polygons
Assessment: Successfully create points using “Mark” and polygons using “Tracks”
Bloom’s level: Knowledge

Lesson Format

1. Introduction to GPS
    1.1. Triangulation
    1.2. Research questions necessitating GPS
        1.2.1. Example 1: tracking animals over space
        1.2.2. Example 2: tracking habitat patches over time
    1.3. Garmin Etrex H
        1.3.1. Operation
        1.3.2. Data acquisition
    1.4. Mapping
        1.4.1. Points, lines, polygons
        1.4.2. Examples using an aerial photograph identifying features to map with points, lines, and polygons
2. School yard mapping
    2.1. Map points and assess
    2.2. Map polygons and assess
    2.3. Alternative activity
        2.3.1. Sketch a map for comparison (typically GPS units are limited, drawing maps by hand engages all students)
    2.4. Bonus activities
        2.4.1. Hide and seek (GoTo function)
        2.4.2. Write name using tracks

Materials

GPS units

Unit 2

Unit objective: Understand the spatial diversity within ecosystems.
Unit sub-objective 1: Identify and map habitat patches within ecosystems.
Unit sub-objective 2: Understand function of map layers for asking and answering ecological questions.
Unit activity 1: Visit and map different ecosystems.
Unit activity 2: Mapping using transparencies (jigsaw)
Assessment 1: Mapped features saved on GPS unit.
Assessment 2: Development and categorization of three research questions for each ecosystem.
Bloom's level 1: Comprehension
Bloom's level 2: Application/Analysis

Lesson Format
Field trip

1. Individual observations (1/2 hour)
2. Mapping (teams of 6; 45 minutes per team)
   2.1. Teams will identify what features characterize and are important for the function of the ecosystem.
   2.2. Teams will identify mapping tasks
   2.3. Individuals will map and save features using points lines and polygons
   2.4. Students will photograph features and record in personal notebooks what, why and how (point, line, or polygon) features were mapped

In class activity1 (Transparencies; implement after first field trip)

1. Introduction
   1.1. Lesson goals and objectives
   1.2. Introduction to GIS
   1.3. Examples and use of layers
      - Aerial photos
      - Ecosystems
      - Elevation
      - Geology
   1.4. Description of student tasks
2. Becoming experts
   2.1. In field trip group, students will work individually and trace map features on transparency sheets.
   2.2. In field trip group, students will work individually by overlaying traced transparencies over aerial photographs of ecosystem to identify spatial patterns.
   2.3. Field trip groups will discuss what, how and why they mapped each feature and what patterns they observed to become experts on the group's map.

3. Teaching other groups.
   3.1. Students will separate into groups of three with one representative of each field trip group and teach each other about the group maps.
   3.2. Groups will brainstorm to create research questions about individual ecosystems.
   3.3. Individually, students will select three research questions they would like to investigate.
   3.4. Individually, students will categorize their three research questions:
      - Noninvestigable
      - Investigable, collect additional data.
      - Investigable, use other resources.

In class activity2 (Google Earth implement after second field trip)

1. Introduction
   1.1. Introduction to Google Earth
      1.1.1. Navigating in Google Earth
      1.1.2. Importing KML/KMZ files
   1.2. Description of student tasks
2. Becoming experts
   - In field trip group, students will work individually to import maps into Google Earth.
   - Field trip groups will discuss what, how and why they mapped each feature and what patterns they observed to become experts on the group's map.
3. Teaching other groups.
   - Students will separate into groups of three with one representative of each field trip group and teach each other about the group maps.
   - Groups will brainstorm to create research questions about individual ecosystems.
   - Individually, students will select three research questions they would like to investigate.
   - Individually, students will categorize their three research questions:
      - Noninvestigable
      - Investigable, collect additional data.
      - Investigable, use other resources.

Materials

- Field trip
  - Master datasheet/clipboard
  - Individual notebooks
  - Cameras with extra batteries
  - GPS units with extra batteries
  - Download cables
  - Aerial photographs
- In class (jigsaw)
  - Computers with Google Earth installed
  - Thumb drives with map files

Unit 3

Unit objective: Understand the temporal diversity within ecosystems and the role of disturbance
Unit sub-objective 1: Identify and map habitat patches within ecosystems
Unit sub-objective 2: Compare features at different time periods post disturbance
Unit activity 1: Visit and map ecosystems with recent fires
Unit activity 2: Mapping using Google Earth or ArcExplorer Online (jigsaw)
Assessment 1: Mapped features saved on GPS unit.
Assessment 1: Development and categorization of three research questions for each ecosystem.
Bloom's level 1: Comprehension
Bloom's level 2: Application/Analysis

Lesson Format

1. Individual observations (1/2 hour)
2. Mapping (teams of 6; 45 minutes per team)
    2.1. Teams will identify what features characterize and are important for the function of the ecosystem.
    2.2. Teams will identify mapping tasks
    2.3. Individuals will map and save features using points lines and polygons
    2.4. Students will photograph features and record in personal notebooks what, why and how (point, line, or polygon) features were mapped

In class activity (ArcExplorer Online)

1. Introduction
    1.3. Introduction to ArcExplorer Online
        1.3.1. Navigating in ArcExplorer Online
        1.3.2. Importing files
        1.3.3. Adding online maps
    1.4. Description of student tasks
2. Becoming experts
    - In field trip group, students will work individually to import maps into ArcExplorer Online.
    - Field trip groups will discuss what, how and why they mapped each feature and what patterns they observed to become experts on the group's map.
3. Teaching other groups.
    - Students will separate into groups of three with one representative of each field trip group and teach each other about the group maps.
    - Groups will brainstorm to create research questions about individual ecosystems.
    - Individually, students will select three research questions they would like to investigate.
    - Individually, students will categorize their three research questions:
        - Noninvestigable

- Investigable, collect additional data.
- Investigable, use other resources.

Materials

- Field trip
  - Master datasheet/clipboard
  - Individual notebooks
  - Cameras with extra batteries
  - GPS units with extra batteries
  - Download cables
  - Aerial photographs
- In class (jigsaw)
  - Computers with internet access
  - Thumb drives with map files

Unit 4

Unit objective: Understand similarities and differences among ecosystems
Unit sub-objective: Select an answer a research question using “other resources”
Unit activity: Select a previously identified research question and answer using GIS techniques
Assessment: Create a series of maps for posters highlighting ecosystems
Bloom’s level: Synthesis/Evaluation

Lesson Format

1. Students will work individually and have research question approved by the instructor.
2. Students will work individually and use tools from previous activities to create maps comparing the different ecosystems.

Materials

- Computers with internet access and Google Earth
- Thumb drives with map files identified from questions in the “investigable, use other resources” category.

Table 1. Ecology unit learning goals alignment table.

Course goals	Unit objectives	Unit sub-objective	Unit activity	Assessment items	Blooms level
Develop an understanding of ecology using ecosystems	Learn to operate GPS units for mapping ecosystem features	Identify and map features on the schoolyard	Map schoolyard using points, lines, and polygons	Successfully create points using "Mark" and polygons using "Tracks"	Knowledge
	Understand the spatial diversity within ecosystems	Identify and map habitat patches within ecosystems	Visit and map different ecosystems	Mapped features saved on GPS unit.	Comprehension
		Understand function of map layers for asking and answering ecological questions	Mapping using transparencies (jigsaw)	Development and categorization of three research questions for each ecosystem.	Application/Analysis
	Understand the temporal diversity within ecosystems and the role of disturbance	Identify and map habitat patches within ecosystems	Visit and map ecosystems with recent fires	Mapped features saved on GPS unit.	Comprehension
		Compare features at different time periods post disturbance	Mapping using transparencies (jigsaw)	Development and categorization of three research questions for each ecosystem.	Application/Analysis
	Understand similarities and differences among ecosystems	Select an answer a research question using "other resources"	Select a previously identified research question and answer using GIS techniques	Create a series of maps for posters highlighting ecosystems	Synthesis/Evaluation