Using Notes from Nature

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Topic: **Digitization and Biodiversity**	
Title: **Using Notes From Nature**	**Course:** **Biology**
Lesson Summary: **Students participate in citizen science by databasing plant specimens on Notes From Nature.**	

Main Science SLE covered in this activity:

ALABAMA: Biology: Unity and Diversity 13. Obtain, evaluate, and communicate information to explain how organisms are classified by physical characteristics, organized into levels of taxonomy, and identified by binomial nomenclature (e.g., taxonomic classification, dichotomous keys).

ARKANSAS: CDL.7. Students shall demonstrate an understanding that organisms are diverse.

7.B.3. Identify the seven major taxonomic categories: kingdom, phylum, class, order, family, genus, species

7.B.4. Classify and name organisms based on their similarities and differences applying *taxonomic nomenclature* using *dichotomous keys*

7.B.5. Investigate Arkansas' *biodiversity* using appropriate tools and *technology*

7.B.17. Describe the structure and function of the major parts of a plant: roots, stems, leaves, Flowers

NS 13. Students shall use mathematics, science equipment, and technology as tools to communicate and solve life science problems.

13.B.2. Use appropriate equipment and technology as tools for solving problems (e.g., Microscopes, centrifuges, flexible arm cameras, computer software and hardware)

14. Students shall describe the connections between pure and applied science.

14.B.4. Explain how the cyclical relationship between science and technology results in reciprocal advancements in science and technology

15. Students shall describe various life science careers and the training required for the selected career.

15.B.1. Research and evaluate science careers using the following criteria: educational

requirements, salary, availability of jobs, working conditions.

FLORIDA: Standard 14. Organization and Development of Living Organisms.
SC.912.L.14.10. Discuss the relationship between the evolution of land plants and their anatomy.
Standard 15. Diversity and Evolution of Living Organisms.
SC.912.L.15.4. Describe how and why organisms are hierarchically classified and based on evolutionary relationships.
SC.912.L.15.5. Explain the reasons for changes in how organisms are classified.
Standard 17. Interdependence.
SC.912.L.17.8. Recognize the consequences of the losses of biodiversity due to catastrophic events, climate changes, human activity, and the introduction of invasive, non-native species.
SC.912.L.17.13. Discuss the need for adequate monitoring of environmental parameters when making policy decisions.

GEORGIA: SCSh4. Students use tools and instruments for observing, measuring, and manipulating scientific equipment and materials.
SCSh8. Students will understand important features of the process of scientific inquiry.
b. Scientific researchers are expected to critically assess the quality of data including possible sources of bias in their investigations' hypotheses, observations, data analyises, and interpretations.
e. The ultimate goal of science is to develop an understanding of the natural universe which is free of biases.
SBO1. Students will use current play phylogenic principles and describe the structural changes used to delineate the plant divisions.
b. Identify and evaluate plant structures in relation to their functions.
c. Use, compare, and contrast the methods and purposes of plant classification.
SBO2. Students will be able to identify and describe Georgia's major physiographic provinces and their natural plant communities
b. Use taxonomic keys to identify local flora and recognize major representative groups of the southeast.

*KENTUCKY: Now using Next Generation Science Standards.
Core Idea LS4: Biological Evolution: Unity and Diversity.
LS4.A. Evidence of Common Ancestry and Diversity.
LS4.D. Biodiversity and Humans
High School Life Sciences
HS. Interdependent Relationships in Ecosystems.
HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. NOTE: This performance expectation integrates traditional science with engineering through a Practice or Disciplinary Core Idea. Using this Lesson Plan can be integrated as part of addressing this Learning Outcome by teaching what biodiversity is, how it can be defined, and how biodiversity differs by habitat and geography.
HS. Natural Selection and Evolution.
HS-LS4-5. Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species. NOTE: This lesson plan addresses the naming of diversity (taxonomy) and its spatial distribution through time. Teachers should emphasize the need for and use of "Big Data" in science (for example, in the form of large aggregate datasets as being compiled through this project) to understand distribution of biodiversity and impacts of environmental changes to changes in biodiversity patterns.

LOUISIANA: Biological Evolution 18. Classify organisms from different kingdoms at several taxonomic levels, using a dichotomous key (LS-H-C4).
19. Compare characteristics of the major kingdoms (LS-H-C5).
20. Analyze differences in life cycles of selected organisms in each of the kingdoms (LS-H-C7).

MISSISSIPPI: Life Science 6. Demonstrate an understanding of principles that explain the diversity of life and biological evolution.

a. Draw conclusions about how organisms are classified into a hierarchy of groups and subgroups based on similarities that reflect their evolutionary relationships. (DOK 2)
- Characteristics of the six kingdoms
- Major levels in the hierarchy of taxa (e.g. kingdom, phylum/division, class, order, family, genus, species)
- Body plans (symmetry)
- Methods of sexual reproduction
- Methods of asexual reproduction

b. Critique data (e.g. comparative anatomy, Biogeography, molecular biology, Fossil record, etc.) used by scientists (e.g. Redi, Needham, Spallanzani, Pasteur) to develop an understanding of evolutionary processes and patterns. (DOK 3)

Biology II. Inquiry 1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

a. Use current technologies such as CD-ROM, DVD, Internet, and on-line data search to explore current research related to a specific topic (DOK 3)

Life Science 5. Develop an understanding of organism classification.

a. Classify organisms according to traditional Linnaean classification characteristics (e.g. cell structure, biochemistry, anatomy, fossil record, methods of reproduction) and the cladistic approach. (DOK 2)

b. Categorize organisms according to the characteristics that distinguish them as Bacteria, Archaea, or Eukarya (DOK 1)
- Nomenclature of various types of plants (e.g. Bryophyta, Tracheophyta, Gymnospermae, Angiospermae, Monocotyledonae, Dicotolydonae, vascular plants, nonvascular plants).

NORTH CAROLINA: Bio.2.2 Understand the impact of human activities on the environment (one generation affects the next).

Bio.2.2.2. Explain how the use, protection and conservation of natural resources by humans impact the environment from one generation to the next.

Bio.3.5 Analyze how classification systems are developed based upon speciation.

Bio.3.5.1. Explain the historical development and changing nature of classification systems.

Bio.3.5.2. Analyze the classification of organisms according to their evolutionary relationships (including dichotomous keys and Phylogenetic trees).

SOUTH CAROLINA: H.B.1A.4. Analyze and interpret data from information texts and data collected from investigations using a range of methods (such as tabulation, graphing, or statistical analysis) to (1) reveal patterns and construct meaning, (2) support or refute hypotheses, explanations, claims, or designs, or (3) evaluate the strength of conclusions.

H.B.1B. Conceptual Understanding: Technology is any modification of the natural world created to fulfill the wants and needs of humans. The engineering design process

involves steps used to solve a problem and often leads to the development of new improved technology.

H.B.6. The student will demonstrate an understanding the ecosystems are complex, interactive systems that include both biological communities and physical components of the environment.

D. Conceptual Understanding: Sustaining biodiversity maintains ecosystem functioning and productivity which are essential to supporting and enhancing life on Earth. Humans depend on the living world for the resources and other benefits by biodiversity. Human activity can impact biodiversity.

TENNESSEE: CLE 3255.Inq.3. Use appropriate tools and technology to collect precise and accurate data.
CLE 3255.1.1. Analyze strategies for classifying organisms.
Checks for Understanding: 3255.1.4. Investigate various approaches to maintain biodiversity.
3255.1.2. Use dichotomous key to identify at least five species found in a local ecosystem.
3255.1.9. Explore careers in conservation biology and bioinformatics.
CLE 3255.6.2. Examine state, national, and international efforts to sustain native species and ecosystems.

VIRGINA: BIO.4. The student will investigate and understand life functions of Archaea, Bacteria, and Eukarya. Key concepts include
c) how the structures and functions vary among and within the Eukarya kingdoms of protists, fungi, plants, and animals, including humans.
BIO.6. The student will investigate and understand bases for modern classification systems. Key concepts include
a) Structural similarities among organisms.
e) Systems of classification that are adaptable to new scientific discoveries.
BIO.8. The student will investigate and understand dynamic equilibria within populations, communities, and ecosystems. Key concepts include
e) analysis of the flora, fauna, and microorganisms of Virginia ecosystems.

WEST VIRGINIA: SC.O.B.1.9. Synthesize concepts across various science disciplines to better understand the natural world (e.g., form and function, systems, or change over time).
SC.O.B.2.17. Compare morphological, cladistic and other classification systems including domains, kingdoms and other taxa.

*Next Generation Science Standards: Many or all of the states in the Southeast region may move to Next Generation Science Standards in the near future. Kentucky is the only state that has made the change to Next Generation Standards so far. As states transition to Next Generation, the frameworks highlighted here will need to be continually updated to reflect the changes in educational outcomes expected in each state. State standards are based on records found in 2015 and may need to be updated.

Objectives: The learner will:

1. Students will contribute to "big data" that will be used for scientific research

2. Students will understand how taxonomic nomenclature applies to real specimens

3. Students will use real specimens to enhance their understanding of biodiversity and how specimens are used in research

4. Students will record geographic and habitat information to gain an understanding of where plant species live and improve their ecological concept of habitat.

Key Words:

Taxonomic nomenclature; citizen science; biodiversity informatics; biodiversity; specimen

Essential Question:

How do scientific specimens contribute to research?

BACKGROUND INFORMATION

Timeline:

90 minutes overall:

5 minutes – pre-survey
10 minutes - introduction
30 minutes – plant specimen production
30 minutes – citizen science using notes from nature
15 minutes – post survey and wrap-up

Materials:
Materials for "Engage":

- Plant press
- Real plants
- Newspaper
- Examples of specimens

Materials for "Explore":

- Computer (1 per student)

Materials for "Evaluate"

- Pre and post surveys

Teacher Preparation:

Plant specimen mounting: Before you decide if you want to do this part of the lesson plan, see if you can borrow some plant presses from a local herbarium or look into making some yourself. There are many DIY instructions online for making plant presses. Also, research how plant specimens are made and used so you can accurately press a plant and show your students how.

Digitization: Make sure your students have access to computers to complete this activity. To prepare, go to http://www.notesfromnature.org/ and transcribe a few specimens (or more!) yourself so you understand the process and can help your students through the activity. Also, research digitization **so you can explain to your students why it is important and how it is helpful to scientific research. Use the following links:**

http://www.spnhc.org/10/why-collections-matter

https://www.idigbio.org/

http://sernec.appstate.edu/

http://herbarium.astate.edu/

Background Information:

Prior to this lesson, students should understand the basics of scientific nomenclature. In this lesson they will identify and apply binomial nomenclature. Students should have a working knowledge of computers and be able to use a website responsibly.

PROCEDURE

Engage:

As students come into class, hand out the pre-assessment surveys. They may complete these while other students are filing in, everyone is getting settled, and you are preparing to begin the lesson.

Bring in fresh plant specimens that students will recognize. Examples are oak, clover, pine, roadside flowers or small yard plants. Make sure you know what the plant is and try to find the scientific name. Show students how plants are pressed and made into specimens. You may be able to borrow specimens and presses from a local herbarium. If not, use pictures of specimens and makeshift presses. Let the students take turns pressing plants to they understand the process. Many specimens can be stacked onto one press so you will only need 1-2 presses per class. Make sure the students record data on the specimen: specimen name, date, student's name, location where collected, any interesting or identifying features of the plant, and habitat.

If you have extra time you may divide this part into a separate day and allow the students to go out and collect the plants on their own. This would give the added opportunity to show students how plants are collected and what makes a specimen research quality.

For more details on making proper scientific plant collections see resources at www.collectionseducation.org.

Explore:

Start by explaining why it is important to catalogue specimens and why it is helpful to scientists to have them digitized. This can be done as you transition from the plant pressing to the computers. Use the following resources to help with your discussion:

Resources:
http://www.spnhc.org/10/why-collections-matter

http://www.virtualherbarium.org/vh/100UsesASPT.html

For this section students will need access to a computer with internet. Once they are at the computer they should follow the following steps as directed on the "Instructions" page.

It may be helpful to choose goals for the students to reach. You may even make it into a game, giving the students tickets for every 5 specimens they transcribe. At the end of the class, you could draw a small prize at random (those with more tickets in the pile will have a greater chance at winning) or you could award a prize to the student with the most tickets/transcriptions**.**

As they transcribe specimens, they should complete the activity sheet. This will give them the information they need to reflect on their transcriptions and participate fully in a class discussion.

Explain:

Once many students have completed 3-5 data entries, ask students what they think these specimens can be used for and how/why. Explain to them why they are correct or incorrect but encourage the students to be intuitive and come up with their own ideas.

Elaborate:

Continue the class discussion by providing information about what scientists do with digital specimens. Consider showing online plant databases such as the Missouri Botanical Garden (http://www.tropicos.org/) and the New York Botanical Garden (http://sciweb.nybg.org/science2/VirtualHerbarium.asp). Talk about efforts to digitize plant specimens as well as other specimens through organizations such as iDigBio and SERNEC and why those are important. Answer any questions students may have.

Evaluate:

Formative evaluation will be accomplished by class discussions and observation of student work. Students will also complete an activity sheet which can be evaluated for understanding.

CROSS CURRICULAR CONNECTIONS

Careers:

Discussing careers in science dealing with botanical sciences and museum studies.

Parental Involvement:

Students may use their accounts to continue databasing specimens at home. Encourage them to get their parents and other family members involved.

Technology Connections:

Computer science