Pharm 693
Kevin Lloyd
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Unit Plan

RISE at DUKE
Raising Interest in Science Education

Teaching Units for High School Science Developed by

Duke University Graduate Students in Pharmacology 693/694

Master of Arts in Teaching (MAT)

http://sites.duke.edu/rise/duke-courses/pharm-693694/

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Ecological Health of the Ellerbe Creek Watershed and its Environmental Implications

Stage 1—Desired Results

Established Goals

North Carolina Standard Course of Study:

- **Bio.2.1** Analyze the interdependence of living organisms with their environment.
- **Bio.2.2** Understand the impact of human activities on the environment.
- **EEn.2.2** Understand how human influences impact the lithosphere.
- **EEn.2.3** Explain the structure and processes within the hydrosphere.
- **EEn.2.4** Evaluate how humans use water.
- **EEn.2.7** Explain how the lithosphere, hydrosphere, and atmosphere individually and collectively affect the biosphere.
- **EEn.2.8** Evaluate human behaviors in terms of how likely they are to ensure the ability to live sustainably on Earth.

College Board AP Course Standards

- ***Biology* - Big Idea 4** Biological systems interact and these systems and their interactions possess complex properties.
    - **4.A** Interactions within biological systems lead to complex properties.
    - **4.B** Competition and Cooperation are important aspects of biological systems..
    - **4.C** Naturally occurring diversity among and between components within biological systems affects interactions with the environment..

Understandings: ***Students will understand that . . .***	**Essential Questions:**
• Interactions among living systems and with their environment result in the movement of matter and energy relating to the significance of each to maintain the health and sustainability of an ecosystem. • Human activities (including population growth, urbanization, pollution, global warming, burning of fossil fuels, habitat destruction, and introduction of non-native species) may impact the environment from one generation to the next. • Sustainable agriculture and aquaculture practices have environmental impacts. • The development and implementation of environmental policy is a complex issue.	• What are the effects of human activities on the overall health of the Ellerbe Creek Watershed? • How do the chemicals we use and consume enter and bioaccumulate in freshwater ecosystems? • What are methods and parameters scientists use to test the chemistry, biology, and physical structure of freshwater ecosystems? • How do scientists translate their research into written, published scientific literature? • How do local governments and environmental groups enact advocacy, policy, and natural resource management plans?

• Ground water and surface water interact. • Humans influence freshwater availability and quality in North Carolina's river basins, wetlands, and tidal environments. • Biodiversity is important to the biosphere. • Distribution of local and global ecosystems changes over time. • The diversity of species within an ecosystem may influence the stability of the ecosystem. • Interactions between and within populations influence patterns of species distribution and abundance.	
Students will know . . . • The importance and biological implications of the water, carbon, nitrogen, and phosphorous cycles • How humans modify ecosystems through population growth, technology, resource consumption, and production of waste • How to interpret data regarding the historical and predicted impact on ecosystems and global climate change • That urban development in the North Carolina Piedmont leads to habitat destruction and urban runoff • The effects of pesticides, herbicides, and pharmaceuticals on freshwater ecosystem health • Local environmental policies and organizations striving for effective conservation methods and stewardship • The general structure of freshwater ecosystems • How humans and other species manipulate and impact freshwater ecosystems for use and consumption • How pollutants flow through a watershed • How drinking water, stormwater, and wastewater systems impact the quantity and quality of water • How to evaluate the quality of North Carolina streams (chemical & physical properties and biotic indices) • Non-point sources of pollution • How biotic and abiotic factors affect biodiversity	***Students will be able to . . .*** • Maintain field notes and accurate records in a field notebook • Develop a methodology for stream sampling • Mathematically calculate the flow rate of streams • Identify common freshwater macroinvertebrates and what their presence or absence means for ecosystem health • Chemically test for pH, dissolved oxygen, and the presence of dissolved nitrogen, phosphorous, detergents, and pharmaceuticals • Use a compass to determine magnetic direction of travel and azimuth measurement • Read and interpret Public Land Survey maps to determine land use and an area's legal description • Read and interpret a primary, scientific journal article through the lens of the scientific method • Analyze collected scientific data • Write a scientific research paper that includes the introduction, materials and methods, results, discussion, and literature cited sections • Verbally present scientific findings to a group of peers and professionals

- How traditional agricultural practices can produce runoff and sedimentation issues in adjacent streams

Stage 2—Assessment Evidence

Performance Tasks:

- *Stormwater Science Case Study:* "Losing the Farm: How Changes in Land Surface Affect Storm Runoff" – students will evaluate precipitation runoff from a land surface and will investigate how urbanization can significantly change the hydrology of an area.
- *Stream Sampling Plan:* Throughout the first week of class, students will be exposed to freshwater sampling and chemical testing techniques. Students will then develop a procedure for the field lab to ensure all necessary parameters and data are collected – stream profile, stream flow, macroinvertebrate collection, toxicology/chemical testing, etc.
- *Student Research Paper* – Students will be exposed to how scientific research is translated into a published academic journal article. Students will research primary literature and use the data collected from the field sampling to write a "scientific journal" research paper complete with abstract, introduction, materials and methods, results, discussion, and literature cited sections. The paper will be a joint project for the students emphasizing how research is published, academic literature, scientific writing, and the peer review process.
- *Durham City Council Presentation* – Three selected students will present the findings of their Ellerbe Creek research to Durham City Council, the Ellerbe Creek Watershed Association, and the citizens of Durham.

Other Evidence:

- Daily review questions
- Daily warm-ups
- Macroinvertebrate identification book/foldable
- *Field Notebook* – Students will be provided with a Rite-in-the-Rain notebook and learn how to take effective field notes and observations
- *Field Technique Mini-labs* – Students will learn techniques that will later be utilized on a comprehensive field laboratory day
- Lab Practical Exam
- Unit Exam

Stage 3—Learning Plan

Learning Activities:

(Day 1)

- Warm-up – Students will brainstorm freshwater field-testing techniques to provide a basis for knowledge in the development of their *Stream Sampling Plan*
- Teacher will guide students through the initial set-up and daily expectations of maintaining and keeping records in a field notebook
- Teacher provides PowerPoint and lecture outlining freshwater ecosystems: river and lake

ecosystems, vertical and horizontal life zones, and seasonal variation and succession.

- *Field Techniques Mini-lab*: Students will work in lab groups to investigate stream flow and water infiltration.

(Day 2)

- Warm-up – Students will learn how to mathematically calculate the flow rate of a stream
- Teacher provides PowerPoint and lecture outlining stream toxicology and chemical hazards: overview of toxicology, common aquatic chemical hazards (pharmaceuticals, heavy metals, agricultural runoff, etc.), and sedimentation/erosion.
- *Field Techniques Mini-lab* – Students will work in lab groups to perform a variety of chemical testing techniques: pH, temperature, nitrogen, phosphorous, detergents, and dissolved O_2.

(Day 3)

- Warm-up – Students will learn how to create a qualitative profile of a stream by examining a drainage canal on campus
- Teacher provides PowerPoint and lecture outlining human use of water resources: the water cycle, water supply renewal and use, human use of dams and reservoirs, and stormwater runoff.
- *Stormwater Science Case Study* – "Losing the Farm: How Changes in Land Surface Affect Storm Runoff." Students will evaluate precipitation runoff from a land surface and will investigate how urbanization can significantly change the hydrology of an area.

(Day 4)

- Warm-up – Develop a definition and idea of what a freshwater macroinvertebrate is by breaking down the word itself. Use embellished pictures to draw out questions in regards to their anatomy and physiology and what these imply about their relationship to stream toxicology.
- Teacher provides PowerPoint and lecture outlining sources of water pollution: pollution (types, effects, and sources), pollution of freshwater streams, pollution of freshwater lakes, and pollution of groundwater.
- *Field Techniques Mini-lab*: Students will learn how to identify freshwater macroinvertebrates indicative of differing levels of stream health. Students will create an identification book/foldable.

(Day 5) -

- Warm-up – Snapshot of a part of policy from the Clean Water Act and have students brainstorm about the positive and negative repercussions of such legislature and their difficulty of enforcement.
- Teacher provides PowerPoint and lecture outlining sustainability of freshwater ecosystems and public policy: importance of aquatic biodiversity, lake and river protection and restoration, politics and environmental policy.
- Environmental policy guest speaker from Duke University

(Day 6)

- Warm-up – Students will use the techniques learned in warm-ups and mini-labs to develop a final *"Stream Sampling Plan"* that will be implemented on day 9 when students conduct the Ellerbe Creek field laboratory
- *Field Techniques Mini-lab* – Students will be instructed on how to use a compass and read and use public land survey maps

(Day 7)

- Field Trip – Ellerbe Creek Watershed: Under the guidance of Katherine Meehan, students will be exposed to the issues facing the Ellerbe Creek Watershed – erosion, pollution, stormwater runoff, current management policies, etc. – by examining Ellerbe Creek near the Duke Diet and Fitness Center near the intersection of Duke and Trinity streets in Durham, North Carolina.

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(Day 8)

- Field Trip – Environmental Protection Agency: Students will visit the EPA Campus in Research Triangle Park, North Carolina to see how the agency functions to reduce pollution and to explore one of the largest "green" buildings in the world and the state-of-the-art laboratories housed within.

(Day 9)

- Ellerbe Creek Field Laboratory – Students will put their "*Stream Sampling Plan"* into effect during a day-long field laboratory at several locations along Ellerbe Creek (Falls Lake confluence, urban confluence near Duke Diet and Fitness, site near headwaters). Students will analyze:
    - Stream buffers – width, profile, and vegetation coverage
    - Stream profiling – depth, width, stream flow (volume and speed), turbidity, large woody debris, and erosion
    - Macroinvertebrate collection
    - Water sampling for chemical testing and water quality – dissolved oxygen, nitrogen, phosphorous, pharmaceuticals, detergents, and pH

(Day 10)

- Warm-up – Students will be given an academic, scientific journal article and will learn of its basic structure and how it corresponds to the scientific method and conducting research.
- Students will concatenate and analyze the collected data from the field laboratory under the guidance of the teacher.

(Day 11)

- Warm-up – From the collected data, students will develop the main framework and bullet points for what their joint paper will address in regards to stream ecosystem function and health.
- Students will be broken into expert groups to research academic, primary literature on one of the topics to be addressed.
- Homework – Students will continue to research their topics and take notes that will help in writing the research paper.

(Day 12)

- Warm-up – Students will examine the intricacies of writing the introduction, materials and methods, results, discussion, and literature cited sections of a research paper. Students will learn how to cite using the *Ecology* format.
- Students from each expert group will be assigned a certain part of the research paper to write. In their new groups, students will work together to write their sections of the research paper.

(Day 13)

- Students will finish writing their sections of the research paper.
- Students will provide one copy of their completed section to the other three groups and the teacher for peer review.

(Day 14)

- Students will create a final version of their assigned sections from the reviewed copies.
- Students will concatenate their sections to create a final copy of the research paper.

(Day 15)

- Students will take the unit exam.
- Students will take the lab practical.

(Day 16)

- Students will give a presentation demonstrating the findings of their Ellerbe Creek research to Durham City Council, the Ellerbe Creek Watershed Association, and the citizens of Durham at a

city council meeting.