



Reading the River, Summer 2003

Reading Our River

Kentucky River's South Fork

A Unit for 11-12th Grade Advanced Math

Owsley County High School

Booneville, Kentucky

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Introduction

Owsley County High School is situated on a knoll overlooking the South Fork of the Kentucky River at Booneville, Kentucky in Owsley County in the southeastern part of the state. Owsley County is in a sparsely-populated, mountainous, rural area which is mainly forested with cleared ridges and river bottomland. The landscape is dotted by remnants of old strip mines and some of which are still operating. The county is divided by Kentucky River's South Fork which flows from south to north and is fed by numerous streams and branches. There is virtually no industry in this county whose county seat has a population of just over 300. The majority of employment comes from government entities with some agricultural industry. Although there is little industry to contaminate its streams, the county's water system is heavily polluted by solid waste and sewage from residencies without proper disposal methods. Strip mining coal has also contributed to pollution of the county's streams and river.

The high school is located on approximately 15 acres bounded by the South Fork of the Kentucky River, a state highway, residential property lines and Sugar Camp Creek which flows into the Kentucky River. Approximately half of the property is part of the Kentucky River flood plain which is used for recreational purposes including golf and track. Sugar Camp Creek is also accessible from the school despite being nearly 60 feet below the level of the school along the nearly-vertical face of a shale bluff. Several years ago a nature trail was constructed that leads from the school down to the creek and along its banks to the Kentucky.

Objectives

In this lesson, students will:

1. Learn different techniques for measuring land area, tree size, stream width, and chemical analysis.
2. Map and survey the school's property and make an analysis of its topography and the different habitats.
3. Conduct an analysis of the river, the stream and various other sources of water on the property including chemical and biological.

4. Investigate the different types of plants growing on the property and make approximations of the size and age of trees using various measuring methods.
5. Identify various sources of water pollution and how it affects the ecosystem here and on waters downstream.
6. Produce maps, surveys, chemical analysis, and other data to support their findings.
7. Determine the role and responsibility of students and the school in environmental issues.
8. Present plans for possible changes to the school's landscape to make it more ecologically friendly.

Procedure

1. Have a general discussion with students about their home area, its river, streams and landforms and how they fit into state and national geography. Briefly discuss the school property and how its location would help determine possible pollution and its causes. Use state and county maps and include topographical maps of the area which includes the school. Discuss the different watersheds of Kentucky and the region and how they are defined and related.

2. Review mathematical concepts, including the Pythagorean Theorem, ratio, and various other ways to measure plants and landforms to provide data for analysis. Go over the various field methods of approximating measurements using limited or no instruments. Show students how to measure the height of a tree using their own steps and a piece of notebook paper. The age of trees can also be determined using basic scientific methods that do not require cutting down the tree. Show students how to make accurate maps of the study area.

3. Demonstrate how students can make a study of the habitat of a stream, using methods of measuring, tree and plant identification, and identification of water creatures. Emphasize that mathematical concepts such as symmetry and polygon identification can be used to identify plants and creatures, including those viewed under a microscope.

4. Emphasize the importance of properly recording data from various means of testing and measuring to include photography.

5. Demonstrate the use of test kits before going into the field, including the LaMotte pH test

kit and the LaMotte dissolved oxygen test kit, along with use a thermometer and a conductivity meter. Discuss the relationship between dissolved oxygen, chemicals, soluble heavy metals and temperature and the impact they have on the environment. Practice using testing methods on water samples from various sources.

6. Integrate the use of guest speakers including conservation officers, UK Extension agents, forestry and fish & wildlife officials.

7. Students will walk the boundary of the property making initial notes about the stream and the river and what they see. Students will also visit two “wet” areas on the property and later determine whether they are natural or manmade and if they may be a source of pollution. Photographs will be taken of important areas. Students will study topographical and other maps of the site and begin the initial stages of constructing their own maps. After determining a scale they will use ratio and proportion for a more accurate map.

8. Students will make a complete habitat evaluation of the stream and river, and chemical, dissolved oxygen, temperature and conductivity tests will be made at sites on the stream, from the Kentucky River, and using water from the school’s two “wet” areas. Biological tests may also be made to identify the presence of E-coli bacteria.

9. Students will field test samples from the river and the stream for aquatic creatures at a different time and will use a microscope to analyze water samples.

10. Recorded data will be analyzed, and students will make a scientific evaluation of the four water sources. Students will compile a final analysis of the waters on the school property, and make recommendations on what can be done.

Kentucky Core Content

Number/Computation

Concepts

MA-H-1.1.1 - Students will describe properties of, define, give examples of, and apply real numbers to both real-world and mathematical situations, and understand that irrational numbers cannot be represented by terminating or repeating decimals.

MA-H-1.1.2 - Students will recognize, define, give examples of, and apply to both real-world and mathematical situations finite arithmetic and geometric sequences and series.

MA-H-1.1.3 - Students will understand how matrices are used to represent real-world data.

Skills

MA-H-1.2.1 - Students will perform addition, subtraction, multiplication, and division with real numbers in problem-solving situations to specified accuracy.

MA-H-1.2.2 - Students will simplify real number expressions such as those containing opposites, reciprocals, absolute values, exponents (integer), roots (square, cube), and factorials.

MA-H-1.2.3 - Students will use matrix addition, subtraction, multiplication (no larger than 2 by 2), and scalar multiplication to solve real-world problems.

MA-H-1.2.4 - Students will determine a specific term of a sequence given an explicit formula and write an explicit rule for the n th term of arithmetic and geometric sequences.

MA-H-1.2.5 - Students will use simple combinations and permutations to count discrete quantities.

Relationships

MA-H-1.3.1 - Students will understand how the following subsets of real numbers relate to each other: natural, whole, integers, rational, irrational, reals.

MA-H-1.3.2 - Students will understand how real number properties (identity, inverse, commutative, associative, distributive, closure) are used to simplify expressions and solve equations.

MA-H-1.3.3 - Students will understand how to use equivalence relations (reflexive, symmetric, transitive) and order relations (less than, greater than, equal to) to solve problems using real numbers.

MA-H-1.3.4 - Students will understand how ratio and proportion can be used in a variety of mathematical contexts and to solve real-world problems.

Geometry/Measurement

Concepts

MA-H-2.1.1 - Students will describe properties of and give examples of geometric transformations and apply geometric transformations (translations, rotations, reflections, dilations), with and without a

coordinate plane, to both real-world and mathematical situations.

MA-H-2.1.2 - Students will define, describe properties of, give examples of, and apply to both real-world and mathematical situations spatial relationships such as betweenness, parallelism, and perpendicularity.

MA-H-2.1.3 - Students will define, describe properties of, give examples of, and apply to both real-world and mathematical situations angle relationships such as linear pairs, vertical, complementary, supplementary, corresponding, and alternate interior angles.

MA-H-2.1.4 - Students will describe properties of, define, give examples of, and apply to both real-world and mathematical situations ratio measures including slope and rate.

MA-H-2.1.5 - Students will describe properties of, define, give examples of, and apply to both real-world and mathematical situations right triangle trigonometric measures (sine, cosine, tangent).

Skills

MA-H-2.2.1 - Students will perform transformations (reflections, translations, rotations, dilations) on figures.

MA-H-2.2.2 - Students will classify two-dimensional and three-dimensional geometric figures according to their characteristics such as lengths of sides; angle measures; and number of sides, faces, edges, and vertices. Students will describe the intersection of a plane with a three-dimensional geometric figure.

MA-H-2.2.3 - Students will determine height and distance using methods of indirect measurement such as similar triangles (including shadow or mirror method) and right triangle relationships (including trigonometric ratios).

MA-H-2.2.4 - Students will use Pythagorean relationships to solve problems in real-world and mathematical situations.

MA-H-2.2.5 - Students will apply the concepts of congruence and similarity to solve real-world and mathematical problems (not including proofs).

MA-H-2.2.6 - Students will calculate surface area and volume of rectangular prisms, pyramids, cylinders, cones, and spheres in problem settings using given formulas.

MA-H-2.2.7 - Students will apply formulas for the slope of a line, distance between two points, and midpoint of a segment to solve problems.

Relationships

MA-H-2.3.1 - Students will solve real-world geometry problems by using algebra.

MA-H-2.3.2 - Students will apply algebra to solve problems involving geometric figures in a coordinate plane.

MA-H-2.3.4 - Students will understand how a change in one or more dimensions of a geometric shape affects perimeter, area, volume, or surface area.

Probability/Statistics

Concepts

MA-H-3.1.1 - Students will understand how standard deviation measures the scatter of a discrete set of real-world data.

MA-H-3.1.2 - Students will recognize that curve fitting (linear, quadratic, exponential) can be used as a method of describing and predicting from a set of data or scatter plot. Students will recognize the appropriate curve for a particular set of data.

MA-H-3.1.3 - Students will describe and give examples of various sampling techniques and biases in data collection.

MA-H-3.1.4 - Students will understand the differences between combinations and permutations.

MA-H-3.1.5 - Students will understand differences between theoretical and experimental probability.

Skills

MA-H-3.2.1 - Students will analyze, interpret results, make decisions, and draw conclusions based on a set of data.

MA-H-3.2.2 - Students will plot a set of bivariate data and select an appropriate curve (linear, quadratic, exponential) of best fit.

MA-H-3.2.3 - Students will organize, display, and interpret statistical models (tables, graphs) of bivariate data.

MA-H-3.2.4 - Students will interpret the results of a probability simulation, draw conclusions, and make predictions.

MA-H-3.2.5 - Students will represent probabilities in multiple ways such as fractions, decimals, percentages, and geometric area models.

MA-H-3.2.6 - Students will determine probabilities in situations involving replacement and non-replacement.

Relationships

MA-H-3.3.1 - Students will understand how outliers affect measures of central tendency.

MA-H-3.3.2 - Students will describe how sampling techniques can influence results.

MA-H-3.3.3 - Students will understand and reason about the use and misuse of statistics and statistical representations such as type of graph and choice of scale.

MA-H-3.3.4 - Students will use data and curve of best fit to make and defend predictions.

Algebraic Ideas

Concepts

MA-H-4.1.5 - Students will apply direct and inverse variation to both real-world and mathematical problems.

MA-H-4.1.6 - Students will recognize, give examples of, and apply the laws of exponents.

Skills

MA-H-4.2.4 - Students will create tables of numerical values of functions including linear, quadratic, absolute value, exponential, and simple piecewise such as some long distance phone rates.

MA-H-4.2.8 - Students will use direct and inverse variation to solve real-world problems.

Relationships

MA-H-4.3.2 - Students will understand how formulas, tables, graphs, and equations of functions relate to each other.

MA-H-4.3.3 - Students will demonstrate how slope shows rate of change in linear functions arising from real-world situations.

MA-H-4.3.5 - Students will show how equations and graphs are models of the relationship between two real-world quantities (e.g., the relationship between degrees Celsius and degrees Fahrenheit).

Materials

1. Camera
2. Lamotte pH test kit
3. Lamotte dissolved oxygen kit
4. Topographical maps
5. Kentucky state maps
6. County maps
7. Internet
8. Various scientific books
9. Various testing materials
10. Transit and other measuring devices
11. Journals
12. Map making materials
13. Water sampling forms