Minnesota Science Teachers Association | Earth Science Teacher Education Project

GEOS 599: Minnesota Environmental Issues Workshop for ESTEP Teachers

July 28 - August 1 2025, Minnesota State University, Mankato
3 graduate credits (or stipend $80/day)

Instructors

Dr. Bryce Hoppie, Professor Emeritus Geosciences, Minnesota State University, Mankato

Dana Smith, Middle School Science Teacher, Bemidji Middle School

For more information: ESTEP coordinator Dana Smith, estep@mnsta.org

Course description

This course will provide professional development for in-service high school science teachers to address new state science standards which emphasize science as a practice more than a body of knowledge (as per the Next Generation Science Standards) and in which high school interdisciplinary earth and environmental benchmarks are specific to issues and human impacts concerning Minnesota soil and water resources. We will take a deep dive into the physical and chemical properties of major Minnesota soil types, as well as how human agricultural practices and natural processes affect soil as a resource and as part of an ecosystem. Then, we will investigate how Minnesota waters are affected by human soil practices, and the relationships between soils, energy and water. The course will be offered as a 1-week, in person investigative workshop which will include multiple field investigations in and around the Mankato area, as well as laboratory experimentation. Students will then apply the practices and pedagogy learned during the week to reflect on their learning.

Learning Objectives

- ➔ Participants will explore the relationships between water, soil and humans through investigating the solid materials of southern Minnesota and the soil and sediment of Minnesota, and compare and contrast various soils and sediments.
- ➔ Participants will model and investigate natural and human induced mass wasting, erosion, transport and deposition of sediment, and how energy and matter interact.
- ➔ Participants will relate the effect of water and anthropogenic activities to mass wasting and erosion, and the economic impact of these events.
- ➔ Participants will look at mitigation solutions and critique/modify them to be more environmentally friendly and cost effective for Minnesota.
- ➔ Participants will investigate Minnesota water quality issues throughout the state and determine the cause and effects of current practices.

Resource Materials provided to attendees.

Schedule of topics and activities

Day 1: The solid materials of southern Minnesota; soil classification, field site visits of various soil and sediment types

Day 2: Soils and pedogenesis; relationships between physical, chemical and biological forces to produce a natural order to Earth surface materials

Day 3: Mass Wasting, Erosion, Transport, and Deposition, and Their Relationship to Energy (… both natural and anthropogenic); mass wasting investigations, field investigation sites in Mankato area

Day 4: Continued field investigation sites to model and view cause and effect relationships between slope, erosion, transport and deposition of sediment; natural and anthropogenic factors affecting mass wasting

Day 5: Soil, Water, Energy and Human Impacts; water quality, field site investigations to Mankato area mitigation sites, water quality testing

Minnesota Student Science Standards Addressed

9E.1.2.1.2 Plan and conduct an investigation of the properties of soils to model the effects of human activity on soil resources. (P: 3, CC: 2, CI: ESS3, ETS2) Emphasis is on identifying variables to test, developing a workable experimental design, and identifying limitations of the data. Examples of variables may include soil type and composition (particularly those found in Minnesota), erosion rate, water infiltration rates, nutrient profiles, soil conservation practices, or specific crop requirements.

9E.3.2.2.1 Evaluate or refine a technological solution to reduce the human impacts on a natural system and base the evaluations or refinements on evidence and analysis of pertinent data.* (P: 6, CC: 7, CI: ESS3, ETS1, ETS2) Emphasis is on prioritizing identified criteria and constraints related to social and environmental considerations. Examples of data for the impacts of human activities may include the quantities and types of pollutants released into air or groundwater, changes to biomass and species diversity, or areal changes in land surface use (for surface mining, urban development, or agriculture). Examples for limiting impacts may range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).

9E.4.2.1.1 Compare, integrate and evaluate sources of information in order to determine how specific factors, including human activity, impact the groundwater system of a region. (P: 8, CC: 2, CI: ESS2, ETS2) Emphasis is on the making sense of technical information presented in a variety of formats (graphs, diagrams and words). Example of sources of information may include student experimental data. Examples of factors may include porosity, permeability, sediment or rock type, recharge or discharge factors, and potential energy. Examples of human factors may include usage rates, run-off, agricultural practices, and loss of wetlands.

9E.2.2.1.3 Develop or use an algorithmic representation, based on investigations of causes and effects in complex Earth systems, to illustrate the relationships within some part of the Earth system and how human activity might affect those relationships. (P: 5, CC: 4, CI: ESS3, ETS2) Emphasis is on students identifying the interacting components of a system, mathematically modeling how those factors interact and accounting for the effects of human activity on the system. Examples may include local systems in which natural and human-influenced variables impact the amount of runoff.

9L.2.2.1.1 Use a computational model to support or revise an evidence-based explanation for factors that have ecological and economic impacts on different sized ecosystems, including factors caused by the practices of various human groups.** (P: 5, CC: 3, CI: LS2) Examples of ecological impacts might include changes in the carrying capacity, species numbers and/or types of organisms present in an environment. Examples of human practices that can have positive or negative impacts, such as stream restoration versus deforestation as an ecological example. Examples of computational models may include online simulations of population dynamics, population ecology, or population growth.

9L.4.2.2.1 Obtain and communicate information about how Minnesota American Indian Tribes and communities and other cultures construct solutions to mitigate threats to biodiversity.* (P: 8, CC: 7, CI: LS2, ETS1) Examples of cultures may include those within the local context of the learning community and within the context of Minnesota. Examples of threats to biodiversity may include climate change, deforestation, urbanization, dam construction or removal, invasive species, human population growth, threatening/endangering species, agricultural practices, extraction, and the use of fossil fuels.

9C.2.1.1.1 Analyze patterns in air or water quality data to make claims about the causes and severity of a problem and the necessity to remediate or to recommend a treatment process. (P: 4, CC :2, CI: PS1) Emphasis is on the scale of the problem and appropriate use of concentration units. Examples of pollutant data may include ozone, lead, particulates, nitrates, or microorganisms. Examples of remediation may include physical, chemical or biological processes

9C.3.2.1.3 Construct an explanation for the phenomenon of solution creation and identify from patterns how the properties of the resulting solution depend on the interactions between solute and solvent or on concentrations of solutes. (P: 6, CC: 1, CI: PS1) Emphasis is on polarity, solubility, boiling point elevation, freezing point depression, and osmosis. Examples may include salts dissolving to make water hard, road salt, antifreeze, oil spills, and reverse osmosis water systems.

9C.4.2.2.1 Communicate and evaluate claims by various stakeholders, including Minnesota American Indian Tribes and communities and other cultures, about the environmental impacts of various chemical processes on natural resources. (P: 8, CC: 2, CI: PS1) Examples of cultures may include those within the local context of the learning community and within the context of Minnesota. Examples of natural resources may include wild rice harvesting, mining of minerals, and access to clean air and water. Examples of chemical processes may include sulfate in water/soil, acid mine drainage, and air and water pollution.

9P.3.2.2.2 Evaluate a solution to a complex energy-related problem based on prioritized criteria and tradeoffs that account for a range of constraints, including cost, safety, reliability, aesthetics, and maintenance, as well as social, cultural, and environmental impacts.* (P: 6, CC: 2, CI: PS3, ETS1) Examples of energy-related problems may be drawn from alternative energy, manufacturing, and transportation systems.

Minnesota Teacher Licensure Standards addressed

This course addresses the following standards from Minn. Rule 8710.4750 Teachers of Science.

For all science teaching disciplines for 9-12 grade:

- design and carry out an investigation
- use sources of information to solve unfamiliar qualitative and quantitative problems and communicate the solution in a logical and organized manner
- use computers to display and analyze experimental and theoretical data

Subp. 4**. Subject matter standards for teachers of chemistry.**

- understand chemical reactions
- explain and predict qualitatively and quantitatively, using solubility rules, the common oxidation states of elements, the activity series of metals and nonmetals, stability of radicals, and the properties of acids and bases
- predict qualitatively and quantitatively, using the Ideal Gas Law, changes in the pressure, volume, temperature, or quantity of gas in a given thermally isolated ideal gas system when the gas is heated or cooled, is compressed or expanded adiabatically, or enters or leaves the system
- perform measurements and calculations to determine the rate of a chemical reaction, the rate expression, half-life of given reaction, the activation energy of a given reaction, and the equilibrium constant of a given reaction

Subp 5. **Subject matter standards for teachers of earth and space science.**

- understand the components that make up the Earth system
- understand energy in the Earth system
- understand human interactions with the Earth system

Subp 6. **Subject matter standards for teachers of life science.**

- use sources of information to solve unfamiliar qualitative and quantitative problems and communicate the solution in a logical and organized manner
- use computers to display and analyze experimental and theoretical data
- demonstrate an advanced conceptual understanding of life science and the ability to apply its fundamental principles, laws, and concepts

Subp 7. **Subject matter standards for teachers of physics**

- understand the kinetic-molecular model of matter and thermodynamics
- explain, using conservation principles, the observed changes in the matter and energy

COURSE CREDIT AND GRADING

You will receive three graduate semester credits through Moorhead State University upon successful completion of the program and assignments. You may choose your grading options. Full participation in all five days of ESTEP program activities and completion of an ESTEP Lesson Plan are the minimum requirements for "passing". This lesson plan should be a modification of an existing lesson (non-three dimensional), OR the creation of a lesson plan you will use in the future. The lesson plan can be completed using this template or you may use this Paul Anderson template, or Marlene's version from 3D Teaching and Learning online class as well. Please make a copy, and name it according to the instructions below. Once your lesson plan is complete, print and reflect on your work using the 3-Dimensional Lesson Screening Tool. Scan and email along with your Lesson Plan.

To qualify for a grade of a B, you must successfully complete your ESTEP Lesson Plan and write a "Reflective Essay" (1-2 pages, 12 pt type, one-inch margins) on how this summer experience will in incorporated into your classroom, i.e., "Three Big Ideas from ESTEP that I Will Bring to my Teaching".

To qualify for a grade of A, in addition to completing the requirements for a grade of B, you must successfully complete a "Topic Essay" (1-2 page, 12 pt type, one-inch margins) on any one Earth science concept, 3 dimensional practice and/or teachercraft, or another topic from the bootcamp that either most interested you and/or about which you learned the most. Describe your understanding of the topic or concept before the bootcamp (including your own misconceptions), what you now understand about the topic/concept, and how you expect you will now approach this topic in your own teaching. You must cite at least one reference when you present your new, deeper understanding, e.g., from handout or text.

Assignments are to be emailed as attachments to:

Dana Smith at dasmedu2018@gmail.com no later than **August 16 2025**. Title each file with your last name first, e.g., "Smith-ESTEP Lesson Plan", "Smith - 3D Screening Tool", "Smith-Reflective Essay", and "Smith-Topic Essay".

You may email Dana or call her at 507-271-2186 with questions.