Social Studies and Science Lesson Plan
West Virginia Symphony Orchestra Young People's Concert Series

Grade Level(s): Third, Fourth, and Fifth

Lesson Title: A Dyeing Tradition: The Science and Social Studies of Spinning and Weaving

Focus: Scientific Inquiry, Identification, Experimentation, Class Discussion, and Comparing

Objectives: See end of lesson for objectives and standards achieved.

Background Information:
This lesson addresses the historical, cultural, and scientific significance of the dyeing process, which was an important part of the spinning and weaving tradition across many cultures and periods. More extensive background on spinning and weaving is included at the end of the lesson plan to be used as needed.

The science and surrounding historical aspects that natural fibers and plant dyeing played in the creation of clothing before the mechanization of the textile industry are extremely important concepts that connect with many cross-disciplinary academic goals and standards. Since the craft of spinning is so prominent in Mr. Cooper's musical telling of *Rumpelstiltzkin*, as well as other versions of the traditional tale, it makes a perfect lead-in to this unit.

Review the background on spinning and weaving and consult the notated references and resource materials as necessary. You may have access to your own materials on this or ancillary subjects.

You have a great deal of flexibility in how to open this discussion with your students. Your approach may be determined by the age and maturity of the students, a well as the curriculum topics that you and your class may be working on at the time. Here are some of the more obvious suggestions:

1. The role of spinning in Mr. Cooper's musical version of *Rumpelstiltzkin* as well as other traditional versions of the story
2. The historical importance of both spinning and weaving across cultures, focusing ultimately upon Appalachian heritage
3. The science of spinning and weaving and the systems of animals and plants that come together to have sustained this craft across thousands of years

Activities (Procedures):

1. One week prior to the beginning of this lesson, assign students to bring in a variety of plant materials and wool/cotton fabric items to use in an upcoming experiment. It may be a good idea to write the list of items on the chalk/white board and ask one or two students to bring in a specific item. Have backup items in case the student(s) are not able to bring their item to class. All experiment items are low to zero cost. Here is a table of possible items:

Plant Material	Fabric Samples
Onion skins	Cotton balls
Tea (bagged)	White athletic socks (old)
Beets (canned)	White Cotton T-Shirts (old)
Leaves (old, dry leaves work better)	White or Pastel Wool Yarn
Flower Petals	
Red Cabbage	

2. On experiment day have several gallons of hot tap water available. Note that heated water (in a coffee pot) works best, but there are potential safety and liability concerns that should be considered. Ensure that there are enough heat-tolerant containers, like beakers and coffee mugs, for each student or pair of students. Ensure that you have a safety plan in place for how the hot water will be transported and transferred to each container (we urge the teacher or teacher aide to serve in this capacity).
3. Open the activity with one of the introductory methods that you have chosen above or on your own to open a discussion on the important role that both spinning and weaving have played for many thousands of years. Be sure to cover at least the basic three steps of the craft: the material preparation process, the spinning process, and the dyeing/weaving process.
4. Announce to the class that they each are now going to take part in an experiment to see what it was like for many of their ancestors to have to dye clothing, yarn, and other items to make their own clothing. Strongly emphasize the need for safety and teamwork. Note that goggles must be worn when handling and stirring hot water dye containers.
5. Demonstrate for the class how to properly stir without spilling, as well as how to handle hot fabric with tweezers. Show all necessary equipment that will be used as part of this activity.
6. Demonstrate the proper documentation and labeling procedure and establish the appropriate clean-up procedure.
7. Show an example of what the finished product should look like.

8. Open a discussion about the different types of natural fibers that have been used by many cultures for spinning and weaving. Contrast the words natural and nonnatural (or man-made) here. Create three columns on the chalkboard or erasable white board. One column will have the heading "Animal"; the second column will have the heading "Vegetable"; and the last column will be entitled "Mineral". A sample completed chart may look like this:

Animal	Vegetable	Mineral
Wool (sheep)	Flax (linen)	Asbestos
Hair (goat,dog)	Hemp	
Fur (rabbit, opossum)	Jute	
Silk (caterpillars)	Cotton	

*If using this lesson with gifted or older students, you may wish to incorporate a corresponding discussion on the taxonomic classifications of each of these charted items at this point.

9. Move the lesson into the activity phase by revisiting how our ancestors used natural ingredients to dye the fiber materials highlighted in the chart above. The class should be directed to divide into groups of two-three students to set up a station – each group of students will be charged with setting up one station per plant matter (with the idea that students will rotate through all stations to record their results). Class counter space may vary per classroom. This activity may also be done on the floor. Student desk tops may be too uneven for this activity.
10. Each station should contain a heat resistant container, one type of plant matter, a cutting or grinding tool, a stirring implement, one type of fabric highlighted in the chart for step 1, a tray, a paper towel roll, and a pen or marker. Once all the stations have been set up, direct the students to put on their safety goggles and carefully use their cutting implements to finely cut up their particular plant matter on a paper towel. Bricks or mortar and pestles can be used to grind tougher material.
11. Students should place the ground plant material into a heat-resistant container and then add the hot water (recommended to be transferred from station-to-station by the teacher). Stir as necessary. Some material may need to be smashed further with a stirring instrument while in the water. If using hot tap water and not heated water, more stirring agitation may be required to create visible colors.
12. Once the water takes on the coloring of the plant, place a small sample of the fabric into the container. Allow the fabric to soak for about five minutes while each student group prepares their tray. The students should now line a tray with a paper towel. The towel should then be labeled with masking tape or by writing directly onto the towel the name of

the plant dye and the name(s) of the student(s). A new towel and tray will be used each time the group rotates to another station. Hot tap water will need to replace cooled water each time a group rotates to a few station.

13. After the five minute waiting period is over, the fabric sample can be removed from the water with a stick or tweezers and placed onto the tray to dry. The fabric should have as much water squeezed out of it as possible. Have the students place each completed tray in a designated part of the room to dry overnight.
14. Follow clean-up procedures as previously given.
15. The following day, allow students to have a brief period of time to compare and contrast the various results each group achieved.
16. Have each student create a chart to show their comparisons/contrasts incorporating the results each group achieved. Note that various groups will likely have different results and stimulate processing time when the charts are completed as to why there were differences (such as variations in fiber colors and types, variations in the amounts of plant materials used, water temperatures may vary, etc.). Encourage the students to use multiple colors in their responses like yellowish-orange. An example of the chart is as follows:

Group Number	Plant Material	Color Achieved
Group 1	Tea	Brownish-Gray
Group 2	Tea	Brown
Group 1	Beets	Reddish-Brown

Extension:

This lesson can be extended over additional periods and for gifted or older students in these and other ways:

1. Do another experiment lab using different types of fibers (not just cotton and wool as before) to gauge the different results that each dye would have in each type of fiber (linen, hemp, etc.).
2. Another follow-up experiment would be to examine the role that mordants played in dyeing techniques by adding alum and cream of tartar to the dyebath and documenting the results. Creating a simple documentation worksheet would be helpful for this stage.

Modifications (Special Needs):

1. Visual and auditory impaired students will need special consideration during this lesson with setting up lab groups and material adaptations.
2. Learning disabled students may benefit by abbreviating this lesson's content and length.

3. Varying learning styles will be addressed with the variety of activities in this lesson – tactile, visual and sensory learning styles are utilized.
4. Gifted student needs are provided through the extension activities.

Assessment/Evaluation*:

1. Formative Evaluation Plan: The teacher will observe and facilitate all discussion points and assess progress of concepts throughout the lesson. Cycling through each student station, the teacher will assess each student's level of participation and understanding.
2. Summative Evaluation Plan: The teacher will assess the outcome of the lesson upon the receipt all completed dye trays. A concluding comparison and contrast discussion and data chart will serve as a terminal evaluation of the students' work.

Supplemental Materials and Equipment Needed:

Large supply of hot tap water in pitchers or carafes
Heat resistant container for each student or pair of students (beakers, evaporating dishes, coffee mugs, etc)
Stirring implements (spoons, wooden skewers, craft sticks, glass rods, or paint stirs)
Various white fabrics (cotton t-shirts, cotton balls, wool yarn, wool athletic socks)
Trays lined with paper towels (scrap cardboard, school lunch trays, etc)
Masking tape
Rolls of paper towels (one per station)
Samples of plant material (onion skins, flower blossoms, cranberries, bark from woodpiles (not living trees), leaves, beets, tea, etc)
Kitchen knives or other safe tools for basic cutting
Several bricks or mortar and pestle for grinding sample material into small bits
Several tweezers for picking up hot fabric
Safety goggles
Several hot mitts
Pens or markers
Creation of a worksheet (if doing the extension activities)

Resources:

Chetwynd, H. (1988). The Weaver's Workbook. New York: St. Martin's Press.
Delaney, C. (1998). Spindle Spinning: From Novice to Expert. Corinth, KY: Kokovoko Press.
Fannin, A. (1981). Handspinning: Art & Technique. New York: Van Nostrand Reingold Company.

For other lesson plans connected to this central topic:
http://www.dairybarn.org/education

References:

Kluger, M. (1991). The Joy of Spinning. New York: Henry Holt and Company.

Answer.com article on the spinning wheel. Retrieved June 6,2005.
http://www.answers.com/topic/spinning-wheel

West Virginia Division of Culture and History article on home industries in early West Virginia. Retrieved August 3, 2005.
http://www.wvculture.org/history/settlementlife.html

Wikipedia reference article. Retrieved June 16, 2005 from
http://www.answers,com/topic/spinning-wheel

National Standards:
Science:
Content Standard A: Develop abilities necessary to do and understand about scientific inquiry
Content Standard B: Develop an understanding of properties of objects and materials
Content Standard C: Develop an understanding of the characteristics of organisms, life cycles or organisms, and organisms and environments
Content Standard D: Develop an understanding of properties of earth materials
Content Standard E: Develop abilities to distinguish between natural objects and objects made by humans
Content Standard F: Develop an understanding of types of resources and science and technology in local challenges

Social Studies:
Geography – The World in Spatial Terms; Places and Regions; Physical Systems; Human Systems; Environment and Society

U.S. History – Living and Working Together in Families and Communities, Now and Long Ago; The History of Student's Own State or Region; The History of Peoples of Many Cultures Around the World

WV Content Standard Objectives:

Third Grade
Science

SC.3.1.1	recognize that scientific explanations may lead to new discoveries (e.g., new knowledge leads to new questions.
SC.3.2.1	demonstrate curiosity, initiative and creativity by planning and conducting simple investigations.
SC.3.2.2	recognize that developing solutions to problems takes time, patience and persistence through individual and cooperative ventures.
SC.3.2.4	use scientific instruments and everyday materials to investigate the natural world (e.g., graduated cylinder, hand lens, metric ruler, magnets, weather instruments, thermometer, calculators).
SC.3.2.5	use safe and proper techniques for handling, manipulating and caring for science materials (e.g.,

follow safety rules, maintain a clean work area, treat living organisms humanely).

SC.3.2.7 interpret data presented in a table, graph, map or diagram and use it to answer questions and make predictions and inferences based on patterns of evidence.

SC.3.3.3 observe that changes occur gradually, repetitively, or randomly within the environment and question causes of changes.

SC.3.4.8 investigate the dissolving of solids in liquids.

SC.3.6.2 listen to and be tolerant of different viewpoints by engaging in collaborative activities and be willing to modify ideas when new and valid information is presented.

SC.3.6.4 describe how modern tools and appliances have positively and/or negatively impacted their daily lives.

Social Studies

SS.3.5.3 compare and contrast present cultures to the cultures of people of other historical time periods (e.g., source of food, clothing, shelter, products used).

Fourth Grade

Science

SC.4.2.1 demonstrate curiosity, initiative and creativity by developing questions that lead to investigations; designing simple experiments; and trusting observations of discoveries when trying new tasks and skills.

SC.4.2.4 use scientific instruments and everyday materials to investigate the natural world (e.g., hand lens, telescope, thermometer, balances, magnets, tuning forks, bulbs and batteries, graduated cylinders, calculators, computers).

SC.4.2.5 demonstrate safe and proper techniques for handling, manipulating and caring for science materials.

SC.4.2.8 interpret data presented in a table, graph, or diagram and use it to answer questions and make decisions.

SC.4.2.9 draw and support conclusions, make predictions and inferences based on patterns of evidence (e.g., weather maps, change of speed in a given amount of time, change in wave motions with changes in energy, variation of plants).

SC.4.4.1 describe the different characteristics of plants and animals which help them to survive in different niches and environments.

SC.4.4.2 associate the behaviors of living organisms to external and internal influences (e.g., hunger, climate, seasons).

SC.4.4.6 identify human uses of plants and animals (e.g., food sources, medicines).

SC.4.4.9 investigate how properties can be used to identify substances.

SC.4.4.10 investigate and compare the dissolving of different solids in a given liquid.

SC.4.4.11 examine simple chemical changes (e.g., tarnishing, rusting, burning).

SC.4.6.2 listen to and be tolerant of different viewpoints by engaging in collaborative activities and modifying ideas when new and valid information is presented from a variety of resources.

Social Studies

SS.4.1.2 work independently and cooperatively to accomplish goals.

Fifth Grade

Science

SC.5.1.1 realize that scientists formulate and test their explanations of nature using observation and experiments.

SC.5.2.1 cooperate and collaborate to ask questions, find answers, solve problems, conduct investigations to further an appreciation of scientific discovery.
SC.5.2.2 formulate conclusions through close observations, logical reasoning, objectivity, perseverance and integrity in data collection.
SC.5.2.4 use a variety of materials and scientific instruments to conduct explorations, investigations and experiments of the natural world (e.g., barometer, anemometer, microscope, computer).
SC.5.2.5 demonstrate safe techniques for handling, manipulating and caring for science materials, equipment, natural specimens and living organisms.
SC.5.2.7 construct and use charts, graphs and tables to organize, display, interpret, analyze and explain data.

Social Studies
SS.5.4.8 explain the relationship of the environment to cultures in the United States.

Kentucky Program of Studies:
Science and Social Studies
S-P-SI-3
Students will use evidence (e.g., observations) from simple scientific investigations and scientific knowledge to develop reasonable explanations.
S-P-SI-4
Students will design and conduct different kinds of simple scientific investigations.
S-P-SI-5
Students will communicate (e.g., speak, draw) designs, procedures, and results of scientific investigations.
S-P-PS-2
Students will understand that materials can exist in different states and some common materials (e.g., water) can change states.
S-4-SI-2
Students will use simple equipment (e.g., plant lights), tools (e.g., rulers, thermometers), skills (e.g., describing), technology (e.g., electronic media), and mathematics in scientific investigations.
S-4-SI-3
Students will use evidence (e.g., descriptions) from simple scientific investigations and scientific knowledge to develop reasonable explanations.
S-4-SI-5
Students will communicate (e.g., graph, write) designs, procedures, and results of scientific investigations.
S-5-SI-2
Students will use appropriate equipment (e.g., watches), tools (e.g., rain gauges), techniques (e.g., classifying), technology (e.g., calculators), and mathematics in scientific investigations.
S-5-SI-3
Students will use evidence (e.g., classifications), logic, and scientific knowledge to develop scientific explanations.
S-5-SI-5
Students will communicate (e.g., draw, speak) designs, procedures, and results of scientific investigations.
S-5-SI-6
Students will review and analyze scientific investigations and explanations of other students.
SS-4-G-8
Students will recognize unique places in regions of the United States.
SS-5-CS-1
Students will understand how culture in the United States has been influenced by languages, literature, arts, beliefs, and behaviors of diverse groups.

Ohio Academic Content Standards:

Science

Physical Sciences Benchmark

3-5 A. Compare the characteristics of simple physical and chemical changes.

Science and Technology Benchmark

3-5 B. Describe and illustrate the design process.

Scientific Inquiry Benchmark

3-5 A. Use appropriate instruments safely to observe, measure and collect data when conducting a scientific investigation.

3-5 B. Organize and evaluate observations, measurements and other data to formulate inferences and conclusions.

3-5 C. Develop, design and safely conduct scientific investigations and communicate the results.

Social Studies

Geography Benchmark

3-5B. Identify the physical and human characteristics of places and regions in North America.

Social Studies Skills and Methods Benchmark

3-5D. Use program-solving skills to make decisions individually and in groups.

*All Assessments are to be at the expected state assessment standard; in West Virginia this is mastery level; in Ohio this is benchmark level; and, in Kentucky, this is academic expectations level.

Spinning

Handspinning is the process of taking raw material (wool, cotton, silk, flax, hemp, etc), that has been cleaned and prepared, and turning it into thread. Until the introduction of the spinning wheel, spinning was done using a drop spindle. The drop spindle is still used in many countries located in South America, Asia, and Africa. It is thought to have been invented in China or India between 500 and 1,000 AD.

The purpose of either tool (spinning wheel or drop spindle) is to add twist to the fiber into a long and continuous strand to make it more cohesive and strong. Fibers without this twist break apart more easily when worked into cloth by weaving or knitting.

Rather than relying on finger-twisting or gravity, the spinning wheel is turned by hand or by treadle (foot pedal). It can sometimes also be turned by water or electric power for very large wheels. The motion of the wheel twists the thread and it is then wound on either a post (called a spindle) or directly onto a bobbin.

Numerous types of spinning wheels exist throughout history. The following are some examples:

1. **"Great wheel" (also called the walking wheel or wool wheel)** – this version is used for the spinning of woolen-spun yarns
2. **Flax wheel** – this version is used to spin linen and worsted-spun yarns
3. **Charka** – This version is a small, portable wheel that is hand-cranked for spinning cotton or other similar fibers

The great wheel may be one of the easiest to use, although it was not as portable. It is usually the height of a person and in order to spin the fiber into yarn, the craftsperson must turn the wheel by hand. Each turn of the larger wheel causes many turns of the smaller wheel. The rotation of the smaller wheel then causes the spindle to turn.

When a person wishes to add more twist to the yarn they are creating, they may hold the fiber away from the wheel enough that the resulting yarn does not wind itself onto the spindle.

The advantage to a great wheel is that you may adjust the tension in the yarn by simply stepping forward or backward. The disadvantage is that one must be standing the entire time (hence the term "walking wheel").

The spinner is a craftsperson transforming material in a form that many people would judge to be unusable into an essential component of clothing we all wear and fastening devices that we use on a regular basis – thread, yarn, or string.

Weaving

One of the most ancient of fundamental arts, current archaeological evidence traces weaving back to some 27,000 years ago.

Weaving was traditionally done on a loom. The weaver would raise and lower different threads and pass a shuttle with another thread between them. The weaver would swing the heavy and comb-like beater toward him/her and pack the thread into place.

Throughout early American history, the weaver often dyed the yarn and thread themselves using bark, roots, flowers or other parts of plants or trees. Common things used as dyes were walnut hulls, sassafras roots, sycamore bark, sumac berries, broomsedge, wild aster flowers, onion skins, indigo and madder. For example, brown color came from walnuts. Yellow colors came from aster petals and indigo made the color blue. Madder plants provided red coloring.

Appalachian Heritage in Spinning and Weaving

The major fiber materials used within the boundaries of present day West Virginia were flax and wool. Cotton was added much later. Hence there were two main types of spinning wheels used in Appalachia: a large wool wheel and a smaller flax spinning wheel.

Flax was an abundant material and was more prevalently used in the looms of the Colonial period. The pioneer family grew flax plants. The fiber of the stalk was used for spinning. It was removed by breaking the tough bark. The "breaking" of the flax was often done my men. There were many steps to prepare the flax for the spinning wheel, which ultimately became the prevalent linen cloth of the period.

Wolves preying upon sheep initially created a problem in obtaining steady sources of wool, but as wolves were eradicated or driven away sheep farming and the resulting woolen cloth increased. Carding was an important step in preparing the wool for spinning. Carding removed the dust particles from wool and straightened the fibers so that they would spin easier. One source noted that it may have taken two full days to prepare enough wool for one day of spinning.

The spinning wheel often had a special place near the fireplace of the pioneer home. Women often came together to do their spinning. Many would talk, sing, and/or pray together while their hands worked the fiber.

From time to time, the spinner would unwind the yarn from the spindle and place it onto a handmade reel (sometimes called niddy-noddy). This device would allow the spinner to gauge the length of the yarn. The length was often given the name skein. Six skeins were often considered a good days work of spinning.

Now it was time to take the yarn and convert it into cloth – called weaving. Weaving was done on looms (often located in the barn). Barn looms were hand-made and very large. Some were very tall and took up more floor space than a double bed.

The bark dyes in the early days of West Virginia were most commonly butternut and yellow oak. The bark of almost every tree actually provided dyeing matter. Their colors are far more subtle than present-day chemical dyes.

