

Modifying the Plow

Grades 3-5

Science, Social Studies, ELA, Visual Art, Math



Objectives

Students will learn how plows have been modified through the years to improve their use and impact on farming. Students will read about the Dust Bowl and discover how Oklahoman Fred Hoeme's modification of the plow helped reduce wind erosion. Students will design a plow replica using a variety of supplies and then test the effect the plow has on a tray of soil. Students will use the elements and principles of design to analyze artwork that portrays plowing fields. Students will discuss the artists portrayal of plowing a field.

Vocabulary

acre— a measure of land area in the United States that equals 4, 840 square yards (about the size of a football field)

dirt clods— lumps of soil or clay

erosion— a wearing away of something by the action of water, wind, or glacial ice

furrow— a long, narrow cut in the ground

modified— to make changes to some parts of something while not changing other parts

plow— a farm machine, pulled behind a horse or tractor, used to cut, lift, and turn over soil

surface crust—a hard surface layer of soil

Background

In order to grow food, farmers must plant seeds. In order to plant a field of seeds, farmers must **plow** the field. When a farmer plows a field, they are breaking through the soil and loosening it to prepare it for the seeds to grow. This is hard to do, because the soil is tough and hard. Soil can also be sticky. When soil is loosened, the topsoil can blow away, which is called soil **erosion**. Soil is a natural resource and farmers must protect the soil. They need soil to provide nutrients for the growing plants which will become food for us to eat.

At one point in time, farmers had to plow a field by hand. To plow one **acre** of land, which is about the size of a football field, the farmer had to spend 96 hours working. When the wooden plow was invented, it could be pulled by a team of oxen or horses. With a wooden plow, farmers could plow an acre of land in only 24 hours. One of the first examples of better technology in farming is the steel plow. John Deere invented the steel plow in 1837. The steel plow allowed farmers to plow an acre of land in only five to eight hours.

Before the steel plow was invented, the sticky soil would cling to the cast iron blade of the wooden plow and farmers would have to stop to clean the blade every few feet. John Deere made life easier for the farmer when he saw a broken steel saw blade. He noticed the blade was slick and polished from use. He thought that soil might not cling to it. He was a blacksmith, so he built a plow blade to use on the farm.

The steel blades on the wooden plows were made of cast iron. The blade John Deere invented was made from steel. John Deere was correct, the soil did not stick to the steel blades. This was a huge time saver for farmers! By 1855, John Deere was selling 13,000 steel plows a year.

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Before the Dust Bowl, tall prairie grass protected the topsoil in Oklahoma. Farmers who lived in the prairies, plowed through the deep-rooted grass and planted wheat. Farmers believed that soil needed to be completely broken apart to make it easier for seeds to grow. They would plow fields and break up all of the **dirt clods** in the field. The goal was to make the soil as fine as possible. The plow would lift the soil up, break the clods apart, and turn the soil back over as it fell back to the ground. It would also create **furrows**, long, narrow cuts in the ground, for planting the seeds. In the 1920's and early 1930's, farmers would often plow a field in the early summer, right after they harvested a crop. However, they would not plant a crop again until fall. This left the fine soil free to blow in the wind, because there were no plants to hold it in place.

In the 1930's a drought swept across the plains. No rain, hot sun, and heavy winds caused soil that had been plowed to blow away. The result was the Dust Bowl and the erosion of soil. When the drought started in 1930, it killed off the wheat. When the wheat died, its roots no longer held the soil in place. High winds blew the topsoil away and left only sand behind. Huge dust storms blew millions of tons of soil into the air. The Oklahoma panhandle was hit the worst. The drought lasted for ten years.

Fred Hoeme was a farmer living near Hooker, Oklahoma during the Dust Bowl. He was concerned about wind **erosion**. Hoeme noticed that road equipment kicked up dirt clods that didn't blow around in the wind like the soil in the plowed fields. This led him to invent the chisel plow. The chisel plow left pieces of previous crops, such as roots and stems, in the field. This helped prevent erosion of the soil, by keeping the soil from blowing away. It also kept the soil from creating a hard **surface crust** when soil dried. This helped the soil take in and hold rainwater. This was important because very little rain fell.

Hoeme and his sons built and sold about 2,000 plows from their farm. In 1938, W.T. Graham bought the rights to make and sell the plows. Graham **modified** the plow and advertised it as the Graham-Hoeme Plow, the "Plow to Save the Plains." It was sold worldwide. By the 1950s, about half of all Great Plain farmers owned chisel plows. The widespread use helped control wind erosion during the seven-year drought of the 1950s. In 2000 a plaque was installed in Hoeme's honor at the Williams Homesteaders Park in Hooker.

There are three main kinds of plows: the moldboard plow, the disk plow, and the chisel plow. The moldboard plow has a broad blade with a curved upper edge that cuts through the soil. As it is pulled over the ground, it cuts deep down into the soil. It cuts a furrow for planting seeds in the soil while also turning the soil. It leaves a mound of loose soil on the side of the blade.

Disk plows have three or more disks on the same axle, which are sloped backward. The disks are each curved inward and turn in a circle as they are pulled over the ground. Disk plows are used on rough ground, on dry ground, or to plow a field with stubble of plants which were left behind by a combine.

The chisel plow has many curved, pointed shanks made of steel on a straight bar. The chisel plow can cut into the soil only a few inches or up to three feet deep. Chisel plows are often used to till the soil because they only cut through the soil, but do not turn it over. This keeps the soil from drying out or blowing away.

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Additional Reading

Collins, David R., *Pioneer Plowmaker: A Story about John Deere (Creative Minds Biographies)*, LernerClassroom, 2002.

Collins, Terry Lee, *John Deere's Powerful Idea: The Perfect Plow (The Story Behind the Name)*, Picture Window Books, 2015.

Garland, Sherry, *Voices of the Dust Bowl (Voices of History)*, Pelican Publishing, 2012.

Lassieur, Allison, *The Dust Bowl: An Interactive History Adventure (You Choose: History)*, Capstone Press, 2016

Nelson Maurer, Tracy, *John Deere, That's Who*, Henry Holt and Co, 2017.

Modifying the Plow

Activity 1- Modifying the Plow

Grades 3-5 Teacher Resources and Standards

Activity 1: Modifying the Plow, (ELA, SS) 2 50 minute class period

Students will read about the Dust Bowl and discover how Oklahoman Fred Hoeme's modification of the plow helped reduce wind erosion.

Oklahoma Academic Standards

Activity 1: Modifying the Plow (ELA, SS)

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|----------|---|
| 4.2.R.4 | Students will begin to paraphrase main ideas with supporting details in a text. |
| 5.2.R.3 | |
| 3.3.R.7 | Students will distinguish the structures of texts (e.g., description, |
| 4.3.R.7 | compare/contrast, sequential, problem/solution, cause/effect) and content by |
| 5.3.R.6 | making inferences about texts and use textual evidence to support understanding. |
| 3.2SS.2c | Examine the interaction of the environment and the people of Oklahoma.
Summarize how the weather and the environment have impacted the economy of Oklahoma in events such as the Dust Bowl, floods, and tornadoes. |
| 3.3SS.12 | Examine notable historic and present-day Oklahomans utilizing biographies and information texts. |

Materials:

- Activity 1 Reading Page 1 “**Modifying the Plow**”
- Activity 1 Worksheet 1 “**Modifying the Plow Comprehension**”
- Activity 1 Reading Page 2 “**What Caused the Dust Bowl**”
- Activity 1 Worksheet 2 “**What Caused the Dust Bowl Comprehension**”

Procedures

1. Use the “**Modifying the Plow**” reading page and comprehension page, along with the “**Modifying Plows- Changes Through the Years**” page (from activity 2) to discuss plows and the modifications made to them.
2. Use the “**What Caused the Dust Bowl**” reading and comprehension page to see what impact plows made on the Dust Bowl

In order to grow food, farmers must plant seeds. To plant a field of seeds, farmers must **plow** the field. When a farmer plows a field, they are breaking through the soil and loosening it to prepare it for the seeds to grow. This is hard to do, because the soil is tough and hard. Soil can also be sticky. When soil is loosened, the topsoil can blow away, which is called soil **erosion**. Soil is a natural resource and farmers must protect the soil. Soil provides nutrients for the growing plants.

At one point in time, farmers had to plow a field using a hand wheeled plow. To plow one **acre** of land, which is about the size of a football field, the farmer had to spend 96 hours working. Using a wooden plow, pulled by a team of oxen or horses, farmers could plow an acre of land in only 24 hours. One of the first examples of better technology in farming is the steel plow. John Deere invented the steel plow in 1837. The steel plow allowed farmers to plow an acre of land in only five to eight hours.

Before the steel plow was invented, the sticky soil would cling to the cast iron blade of the wooden plow and farmers would have to stop to clean the blade every few feet. One day, John Deere, a blacksmith, saw a broken steel saw blade. He noticed the blade was slick and polished from use. He thought that soil might not cling to it. He built a steel plow blade to use on the farm. The blades on the wooden plows were made of cast iron. The blade John Deere invented was made from steel. John Deere was correct, the soil did not stick to the steel blades. This was a huge time saver for farmers! By 1855, John Deere was selling 13,000 steel plows a year.

Today, there are three main kinds of plows: the moldboard plow, the disk plow, and the chisel plow. The moldboard plow has a broad blade with a curved upper edge that cuts through the soil. As it is pulled over the ground, it cuts deep down into the soil. It cuts a furrow for planting seeds in the soil while also turning the soil. It leaves a mound of loose soil on the side of the blade.

Disk plows have three or more disks on the same axle, which are sloped backward. The disks are each curved inward and turn in a circle as they are pulled over the ground. Disk plows are used on rough ground, on dry ground, or to plow a field with stubble of plants which were left behind by a combine.

The chisel plow has many curved, pointed shanks made of steel on a straight bar. The chisel plow can cut into the soil only a few inches or up to three feet deep. Chisel plows are often used to till the soil because they only cut through the soil, but do not turn it over. The chisel plow leaves pieces of previous crops, such as roots and stems, in the field. This helps prevent erosion of the soil, by keeping the soil from blowing away. Fred Hoeme, a farmer living near Hooker, Oklahoma, invented the chisel plow in 1933, during the Dust Bowl because he was concerned about wind **erosion**.

Modifying the Plow

Activity 1 Worksheet 1: Modifying the Plow Comprehension



Name: _____ Date: _____

Why was the steel plow a time saver for farmers? How did it make plowing better?

Why do you think it would be important for farmers to prevent soil erosion?

How did the inventors use science to modify the plow and protect the Earth's soil?

Based on what you read, if you want to prevent erosion, which plow do you think would be the best to use on a field? Explain your answer

If you were going to modify a plow today, which plow would you change? Why?

Before the Dust Bowl, tall prairie grass protected the topsoil in Oklahoma. Farmers who lived in the prairies, plowed through the deep-rooted grass and planted wheat. Farmers believed that soil needed to be completely broken apart to make it easier for seeds to grow. They would plow fields and break up all of the **dirt clods** in the field. The goal was to make the soil as fine as possible.

The plow would lift the soil up, break the clods apart, and turn the soil back over as it fell back to the ground. It would also create **furrows**, long, narrow cuts in the ground, for planting the seeds. In the 1920's and early 1930's, farmers would often plow a field in the early summer, right after they harvested a crop. However, they would not plant a crop again until fall. This left the fine soil free to blow in the wind, because there were no plants to hold it in place.

In the 1930's a drought swept across the plains. No rain, hot sun, and heavy winds caused soil that had been plowed to blow away. The result was the Dust Bowl and the erosion of soil. When the drought started in 1930, it killed off the wheat. When the wheat died, its roots no longer held the soil in place. High winds blew the topsoil away and left only sand behind. Huge dust storms blew millions of tons of soil into the air. The Oklahoma panhandle was hit the worst. The drought lasted for ten years.

Fred Hoeme was a farmer living near Hooker, Oklahoma during the Dust Bowl. He was concerned about wind **erosion**. Hoeme noticed that road equipment kicked up dirt clods that didn't blow around in the wind like the soil in the plowed fields. This led him to invent the chisel plow. The chisel plow left pieces of previous crops, such as roots and stems, in the field. This helped prevent erosion of the soil, by keeping the soil from blowing away. It also kept the soil from creating a hard **surface crust** when soil dried. This helped the soil take in and hold rainwater. This was important because very little rain fell.

Hoeme and his sons built and sold about 2,000 plows from their farm. In 1938, W.T. Graham bought the rights to make and sell the plows. Graham **modified** the plow and advertised it as the Graham-Hoeme Plow, the "Plow to Save the Plains." It was sold worldwide. By the 1950s, about half of all Great Plain farmers owned chisel plows. The widespread use helped control wind erosion during the seven-year drought of the 1950s. In 2000 a plaque was installed in Hoeme's honor at the Williams Homesteaders Park in Hooker.

Modifying the Plow

Activity 1 Worksheet 2: What Caused the Dust Bowl Comprehension



Name: _____ Date: _____

Explain how farmers helped cause the Dust Bowl.

How did drought and wind affect the soil of the plowed fields during the Dust Bowl?

Do you think leaving plants in the field can help prevent soil from erosion.

The Graham-Hoeme Plow was advertised as the “Plow to Save the Plains.” Why do you think they chose this slogan?

If you were a farmer, would the slogan make you want to purchase the plow? Why?

Modifying the Plow

Activity 2- Plowing the Land

Grades 3-5 Teacher Resources and Standards

Activity 2: Plowing the Land, (Sci, SS, Math STEM) 2 50 minute class period

Students will design a plow replica using a variety of supplies and then test the effect the plow has on a tray of soil. Students will learn about wind erosion.

Oklahoma Academic Standards

Activity 2: Plowing the Land (Sci, SS, Math, STEM)

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|-------------------------------|--|
| 3-ESS3-1 | Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard. |
| 4-ESS2-1 | Plan and conduct investigations on the effects of water, ice, wind, and vegetation on the relative rate of weathering and erosion. |
| 5-ESS3-1 | Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment. |
| 4.1SS.3b | Summarize the role of citizens as responsible stewards of natural resources and the environment. Identify present-day examples to conserve natural resources and the development of alternative, sustainable energy sources. |
| 3.D.1.1
4.D.1.2
5.D.1.2 | Use tables, bar graphs, timelines, and Venn diagrams to display data sets. Create and analyze line and double-bar graphs with whole numbers, fractions, and decimals increments. |
| 5.GM.3.4 | Recognize and use the relationship between millimeters, centimeters, and meters to measure and compare objects. |

Materials:

- Activity 2 “**Modifying Plow- Changes Through the Years**” page
- 9” x 13” pan with lightweight potting soil or sand
- sticks, shells, rocks, washers, plastic spoons, forks, or knives
- popsicle sticks, pipe cleaners, aluminum foil
- dowel rods, washers
- glue, tape, hot glue guns, measuring tape, ruler
- water, fan

Modifying the Plow

Procedures

1. Divide students into groups of 4-5. Provide each group with an assortment of supplies, eg. sticks, shells, rocks, washers, plastic spoons, forks, or knives. The aluminum foil will represent metal used by a blacksmith. The pipe cleaners can be used to help shape the foil by building the shape and then covering the pipe cleaner with foil. The popsicle sticks represent any wood that might be needed. Encourage students to be creative.
2. Groups will design and build their own plow by either creating their own design or modifying an existing one. Pass out “**Modifying the Plow- Changes Through the Years**” page for students to see various plows. They can build a moldboard plow, disk plow, chisel plow, or invent a new type of plow. Use the AITC Engineering Process student sheets for groups to design their plow, before they start building.

BEFORE TESTING THE PLOWS *(You might want to complete testing outside):*

—Before testing the plows, measure the distance from the soil to the top of the pan in millimeters or centimeters. Then, use a fan to blow over the soil in the pan for a predetermined amount of time (1-3 minutes). Measure with the ruler to see how much soil moved. Explain that is what happens to soil due to wind erosion. This will be a baseline for all groups, to see if their plows prevent as much soil from blowing, or cause more soil to blow, when the field is remeasured, while also leaving furrows.

CHALLENGE FOR PLOWS:

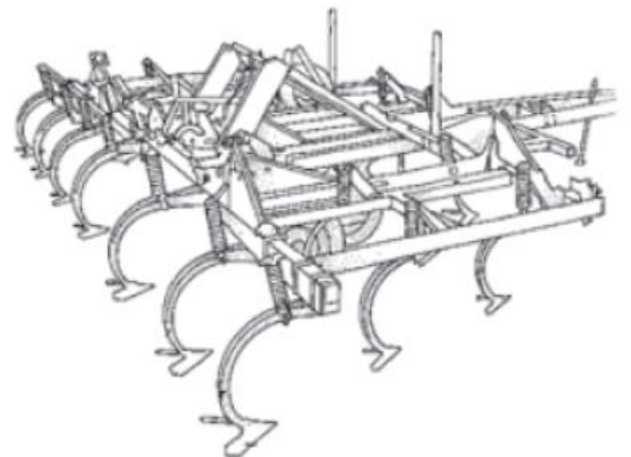
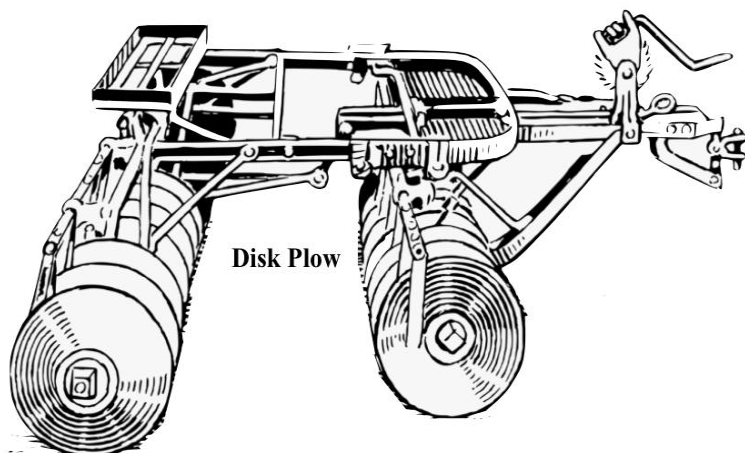
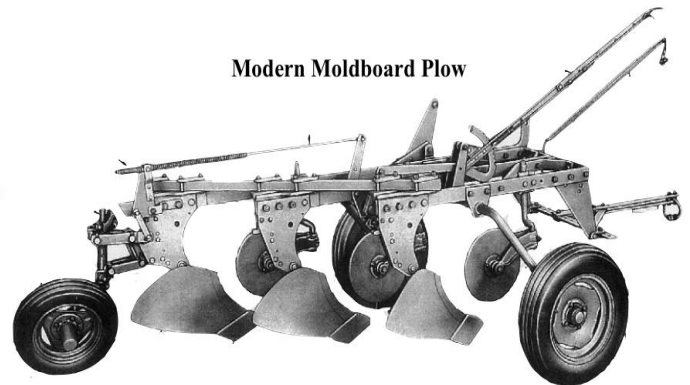
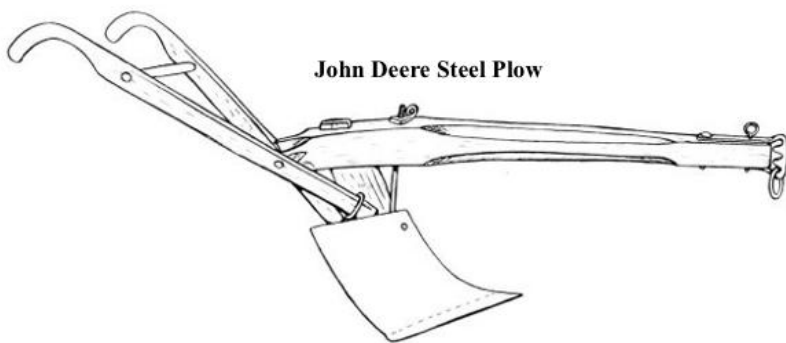
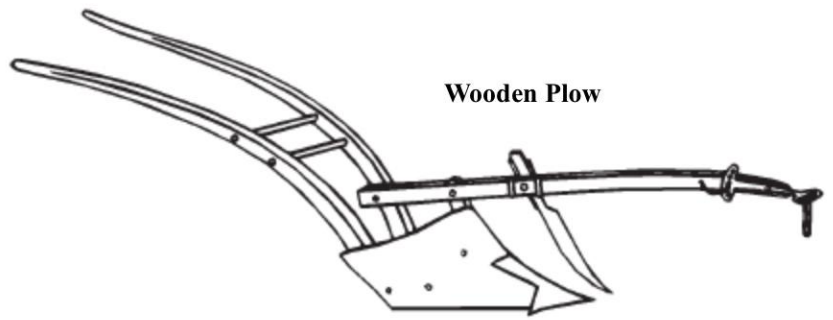
- Build a plow that can be pulled through the soil and leave furrows behind it.
- The plow can leave 1, 2, or 3 furrows behind it.
- Without pushing down on the plow, drag the plow from one end of the “field” to the other. Use a ruler or tape measure to measure the depth of the furrow left by the plow in millimeters or centimeters. If a plow is too light to make furrows, add washers to the top of it to increase the applied force.
- Then, use a fan to blow over the soil in the pan for a predetermined amount of time (1-3 minutes). Measure with the ruler to see how much soil moved. Groups will record their results. Did their plowing prevent soil from blowing, or cause more soil to blow, when the field was measured? Did their plow leave furrows.
- Allow groups to modify their plow and retest, recording their results each time.

5. Each group will graph their results to share with the class. Graphs should include depth of furrows, and changes to the depth of soil when measured.
6. Students will compile their results and rank which plows prevented soil from blowing away. They will also rank which plows caused the most soil to blow away.
7. Students will discuss how each plow either prevented or caused soil erosion.
8. Create a class graph showing compiled results.
9. Students can retest their plows, but instead of using a fan to test wind erosion, use water to test water erosion.

EXTENSION:

Plant grass or wheat seeds in the soil. Once the plants have grown, retest the plows to see if having plants in place to hold the soil will help prevent soil erosion.

Activity 2: Modifying the Plow- Changes Through the Years



Modifying the Plow

Activity 3: Plows in Art, (Visual Art) 2 50 minute class period

Students will use the elements and principles of design to analyze artwork that portrays plowing fields. Students will discuss the artists portrayal of plowing a field.

Oklahoma Academic Standards

Activity 3: Plows in Art (Visual Art)

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|----------|---|
| 3.VA.1.2 | Describe and use the elements of art, including: line, color, form, shape, texture, |
| 4.VA.1.2 | value (light and dark), and space in works of art. |
| 5.VA.1.3 | |
| 3.VA.1.3 | Describe and use the principles of design, including: rhythm, balance, contrast, |
| 4.VA.1.3 | movement, variety, center of interest (emphasis), and repetition in works of art. |
| 5.VA.1.2 | |
| 5.VA.1.4 | Identify and discriminate between types of shape (geometric and organic), colors (primary, secondary, complementary, intermediates, neutrals, tints, tones, shades, and values), lines (characteristics, quality), textures (tactile and visual), and space (background, middle ground, foreground, placement, perspective, overlapping, negative space, positive space, size, color) in his/her own artwork and the artwork of others. |

Materials:

- Oklahoma Ag in the Classroom website
- Activity 3 Worksheet 1 “**Plows in Art: Elements of Design**”
- Activity 3 Worksheet 2 “**Plows in Art: Principles of Design**”

Modifying the Plow

Procedures

1. Go to “Resources” on the Oklahoma Ag in the Classroom website and click on “Ag in Art.”
https://agclassroom.org/ok/resources_classroom/art.php
2. In the “Crops” and “Farm Scenes” categories, locate paintings that include plows.
3. Students will compare and contrast the different styles used to portray the different aspects of farm work.
4. Compare the paintings “Plowing” by Anton Mauve and “The Brush Harrow” by Winslow Homer
Plowing: https://agclassroom.org/ok/resources_classroom/images/art/scenes/plowing.jpg
Brush Harrow: https://agclassroom.org/ok/resources_classroom/images/art/animals/brush.jpg

QUESTIONS:

- What is being used to drag the plow across the ground?
 - What is providing the energy for the work taking place?
 - What type of plow is in each painting: a moldboard plow, a disk plow, or a chisel plow?
5. Compare and contrast the plow shown in “The Last Furrow” by Winslow Homer with the plow in “Fall Plowing” by Grant Wood
Last Furrow: https://agclassroom.org/ok/resources_classroom/images/art/animals/last.jpg
Fall Plowing: https://agclassroom.org/ok/resources_classroom/images/art/crops/fallplow.jpg

QUESTIONS:

- Identify and discriminate between types of shape (geometric and organic); colors (primary, secondary, complementary, intermediates, neutrals, tints, tones, shades, and values); lines (characteristics, quality); textures (tactile and visual); and space (background, middle ground, foreground, placement, perspective, overlapping, negative space, positive space, size, color) in the artwork of each artist.
 - Both paintings show a very simple hand plow with apparently enormous fields in the background. Consider the amount of work it would have taken to plow all those fields using the plow that is pictured.
6. Compare the paintings “Spring Plowing” by Edvard Munch and “Spring Plowing” by Thomas Hart Benton
Munch: https://agclassroom.org/ok/resources_classroom/images/art/scenes/spring.jpg
Benton: https://agclassroom.org/ok/resources_classroom/images/art/crops/spring.jpg

QUESTIONS:

- Use the elements of art, including: line, color, form, shape, texture, value (light and dark), and space in works of art to compare and contrast the paintings.
- Describe each painting using the principles of design, including: rhythm, balance, contrast, movement, variety, center of interest (emphasis), and repetition in works of art.
- Discuss how the artists portrayed the amount of hard work required to plow a field.

Modifying the Plow

Activity 3 Worksheet 1: Plows in Art: Elements of Design



Name: _____ Date: _____

Discuss how the artist uses the elements of design to portray the life of a farmer plowing a field.

Name of Painting:

Artist:

Elements of Design

Describe the lines you see in the painting. Are they mostly thick or thin? Are they mostly implied, vertical, horizontal, diagonal or contour?

Discuss the form in this painting. How is light and shading used to create the form?

Discuss the value—the light and dark in the painting. Is it mostly light or mostly dark?

Modifying the Plow

Activity 3 Worksheet 2: Plows in Art: Principles of Design



Name: _____ Date: _____

Discuss how the artist uses the principles of design to portray the life of a farmer plowing a field.

Name of Painting:

Artist:

Principles of Design

Describe the balance in the painting. What elements (objects, values, color, texture, shape, form, etc.) are used to create balance.

Identify any contrast you find in the painting. What different shapes do you see in the background? How do they bring other objects forward.

Describe the movement in this painting. What objects are used to create the movement?

What is the painting's center of interest? What makes it the center of interest?
