

5E Arts Integrated STEM Lesson Plan

Lesson Title: Visual Arts in the Nature of Science

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Topic: The NATURE of SCIENCE Using the NOS Matrix

Targeted Grade Level: Middle School, Grade 8

Time Needed: 7 class periods at 60 minutes each (Second week of school)

Subject Integration: Art, Science, Math

Justification: In science, discovery is an investigation. It is something that piques your interest and you want to learn and explore more. One seeks the details as well as the why and how. In art, one must attend to the detail of observation as well through a specific medium instead of an experiment. In math, shapes and angles follow equations and logic. Math is integrated into both science and art as often artists use scale and grids to organize the numbers, shapes, and ideas. Art, Science, and Math are a logical integration due to the steps that are adhered to and the detail to precision. This integration enhances the students understanding of the **processes** of each subject. Science, art, and math are all processes that require organization, innovation, and patience. The scientific method (including the engineering design process) could be compared the steps of solving a mathematical problem and compared to the artistic process from inception to creation. ***This lesson focuses on the process and practice alignment of art, science and math.***

Standards:

National Art Standards

Creating:

Anchor Standard #2: Organize and develop artistic ideas and work

Presenting:

Anchor Standard #6 Convey meaning through artistic presentation of work

Students collaboratively examine and respond to a body of contemporary artworks in order to make interpretations of meaning conveyed through such works.

Interpreting and sharing artistic work

Responding:

Anchor Standard #9 Apply criteria to evaluate artistic work

Students collaboratively exhibit their work and develop an exhibition narrative to guide viewers.

Connecting:

Anchor Standard #11 Relate artistic ideas and works with societal, cultural, and historical context to deepen understanding.

NGSS Nature of Science (NOS) Matrix Grades Middle School:

Scientific Investigations Use a Variety of Methods

Scientific Knowledge is Based on Empirical Evidence

Scientific Knowledge is Open to Revision in Light of New Evidence

Scientific Models, Laws, Mechanisms, and Theories Explain Natural Phenomena

Science is a Way of Knowing

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

Science is a Human Endeavor

Common Core Math Standards Grade 8:

(1) formulating and reasoning about expressions and equations, including modeling an association in bivariate data with a linear equation, and solving linear equations and systems of linear equations; (2) grasping the concept of a function and using functions to describe quantitative relationships; (3) analyzing two- and three-dimensional space and figures using distance, angle, similarity, and congruence, and understanding and applying the Pythagorean Theorem.

NGSS Performance Expectations This is not applicable to the NGSS Nature of Science NOS Matrix.

Science and Engineering Practices

Disciplinary Core Ideas

Crosscutting Concepts:

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|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|------------------------------------------------------------------------------|
| Colorado does not have Standards for the Nature of Science | Colorado does not have Standards for the Nature of Science | Communication Collaboration Creativity Computational Thinking (5 C) |
| <p style="text-align: center;">Common Core State Standards:</p> <p>Math: Mathematical Practices for Grade 8:</p> <ol style="list-style-type: none">1. Make sense of problems and persevere in solving them.2. Reason abstractly and quantitatively.3. Construct viable arguments and critique the reasoning of others.4. Model with mathematics.5. Use appropriate tools strategically.6. Attend to precision.7. Look for and make use of structure.8. Look for and express regularity in repeated reasoning. <p>ELA: <i>n/a</i></p> | | |
| ITEEA Standards <i>n/a</i> | | |
| National Art Standards | | |

Creating:

Anchor Standard #2: Organize and develop artistic ideas and work

Presenting:

Anchor Standard #6 Convey meaning through artistic presentation of work

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Interpreting and sharing artistic work

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Students collaboratively exhibit their work and develop an exhibition narrative to guide viewers.

Connecting:

Anchor Standard #11 Relate artistic ideas and works with societal, cultural, and historical context to deepen understanding.

Measurable Student Learning Objectives:

Students will be able to analyze a piece of art by using and applying the standards of Nature of Science

Students collaboratively exhibit their work and develop an exhibition narrative to guide viewers.

Students will be able to apply criteria to observe art and reflect upon art.

Students will be able to organize and convey meaning of the practices of science and math used in art creation.

Students will be able to compare and contrast the processes and practices involved in scientific, mathematical, and artistic activities.

STEM METHODS Connections: This lesson on Nature of Science takes a piece of art and leads students to make a connection between art meaning and science, “Scientific explanations are subject to revision and improvement in light of new evidence” and “Science findings are frequently revised and/or reinterpreted based on new evidence” as shown in the category of “Scientific Knowledge is Open to Revision in Light of New Evidence.” Since math is also integrated, students will take new information and add it to the “body of knowledge” and that “science knowledge is cumulative” as stated in the Nature of Science understandings most closely associated with Crosscutting Concepts, “Science is a way of knowing” (The Nature of Science, 2013). In the Common Core State Standards for Mathematics for grades 6–8, students “modeling with mathematics typically means representing and/or solving a one-step or multi-step word problem, possibly one in which certain assumptions necessary to formulate the problem mathematically are not specified for the student.” (Appendix 1, 2013).

Engaging Context/Phenomena: My hook or phenomena for this lesson will be a large piece of art titled, “*Self Portrait with Thorn Necklace and Hummingbird*” by Frida Kahlo. I will place the piece of art at the front of the classroom with the title of art posted. I will have students observe the piece by asking what is the art, science, and math component of the art. It may be interesting to them since it a self-portrait. This may be an artist that they have seen before. I am hoping that it is engaging to all learners since it has a human, plant, and animals. It is likely that they have not done an activity like this in the past, making it a novel experience.

Data Integration:

A Nasa Resource that will be used in this lesson is a collection of art from Nasa Art Program:

<https://www.flickr.com/photos/nasacommons/sets/72157633977913266/with/8973492146/> The Nasa Art Program has 25 pieces of art in their collection on Flickr. Students will be analyzing this art and collecting mostly qualitative data and observations about the art. Through this data integration they start to see patterns and develop skills to understand the connection between math, science, and art.

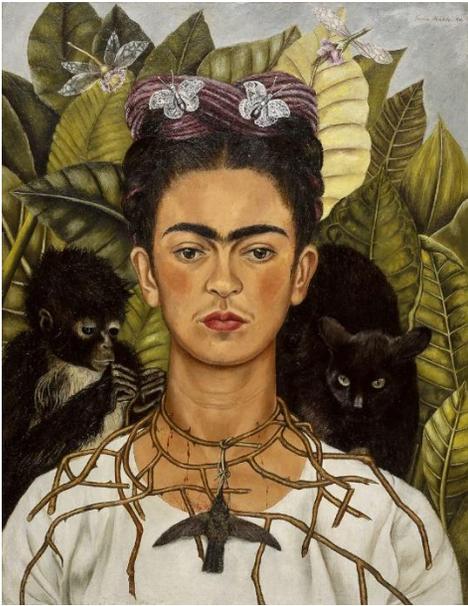
Differentiation of Instruction: This lesson can be adjusted to meet the needs of all students by first evaluating their different needs. Since there is a level of student choice (which piece of art) (individual, partner, or group work) that can lend itself to students using their preferred method of interaction. During the Engage phase, I anticipate that students will feel frustrated by the open ended questions. I can anticipate that students will be able to see the connection of math,

science and art. However, it may be difficult for them to link the Nature of Science to the activity. Therefore, I will have concrete examples. Examples could be a lab sheet and a math worksheet with the relevant steps and ideas. I can also use the diagram “Common Processes in Science and Arts Education” (see Teacher Background) link art and science processes.

Real-life Connection: The real life connection is that students can pick any piece of art that they choose. This will allow them to connect their interest in art (whether it is photography or anime) to their real life. Another connection students can make to real life is that they will start to see that science is everywhere even in art. They may see that even an artist thinks about science in some form- flowers, human anatomy etc. The art that students will investigate will be by artists from different backgrounds positively depicting a range of cultures (Including example of Kahlo). Some students will have the background of geometry and will be able to relate to shapes and formulas working together.

Possible Misconceptions: Misconceptions that students tend to have is that science is an isolated concept. As are all of the classes students take. They do not understand the multidisciplinary nature of all subjects. Another misconception could include that there are not similarities in the processes and practices of math, art, and science.

Lesson Procedure:

| 5E Model | 5E Objectives |
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| <p><u>Engage</u></p> <p><i>The piece of art is the phenomenon. Students will investigate a piece of art by answering questions about art, math, and science.</i></p> | <p>Procedure: I will display a large piece of artwork by Frida Kahlo. “Self-portrait with Thorn Necklace and Hummingbird” (1940). Photo from Wikipedia.org</p>  <p>I will ask the following questions: What is the art in this? What is the science in this?</p> |

What is the math in this?

Students may be puzzled by the phrasing of the questions, but I want students to just write freely and not worry about correct answers. These are open ended questions for that reason.

Students may access their prior knowledge and critical thinking skills.

After each question students will post their answers on sticky notes on the board by the art piece. I will give students a certain color for each subject and ask that they write at least **three** things.

After the activity is complete I will read out loud what is on the sticky notes. We will discuss as a class:

“Are these the right answers? Are any wrong?” WHY? What are you using for criteria to decide if something is right or wrong?

Modifications: I will ask students to write at least one thing for each subject.

Standards Addressed: NGSS NOS Middle School

Scientific Investigations Use a Variety of Methods

-Science investigations use a variety of methods and tools to make measurements and observations.

-Science investigations are guided by a set of values to ensure accuracy of measurements, observations, and objectivity of findings.

-Science depends on evaluating proposed explanations.

-Scientific values function as criteria in distinguishing between science and non-science.

Formative/Summative Assessments –The assessment will be to glance at the student work to see if they can write three words. Or if they are totally stuck by the open-ended question. I will be looking to see if they are making observations.

Resources: Piece of art by Frida Kahlo.

The piece of art I am using is called, “Self Portrait with Thorn Necklace and Hummingbird” 1940.

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| | <p>Different colors of sticky notes.</p> <p>You may use a different piece of art. Author note * I happen to have this as a large piece so it will help students see it if sitting far away.</p> |
| <p><u>Explore</u></p> <p><i>Students will an investigate a piece of Nasa art by answering questions about art, math, and science. After this introductory activity, students will then explore on their own.</i></p> | <p>Procedure: Students will pick a piece of art online. There will be laptops with images posted from NASA Art Program. There are paintings, photographs, and drawings to evaluate. Student will visit art and answer questions about that piece of art on a sheet by themselves. The teacher is quiet and will let students work silently</p> <p>Questions students will be answering are: (These questions are the worksheet)</p> <p><i>Analysis of Art</i></p> <p>Name _____ pd. _____</p> <ul style="list-style-type: none">- What do you think the artist is trying to convey in this piece?- What do you think the process was during the creation of this art?- Explain examples of math that you see in this piece. What makes you say that?- Explain examples of science that you see in this piece. What makes you say that?- What are some science processes that you can use to explain this piece? <p>After the students answer their questions, students with the same piece of art will discuss the differences and similarities of their answers.</p> <p>After class discussion, introduce the objectives to class and pass out copies for students to keep.</p> |

The Visual Arts in the Nature of Science

| Self Evaluation | Objective | Teacher Evaluation |
|-----------------|-----------------------------------------------------------------------------------------------------------------|--------------------|
| | Analyze a piece of art by using and applying the standards of Nature of Science | |
| | Exhibit their work and develop an exhibition narrative to guide viewers | |
| | Apply criteria to observe art and reflect upon art. | |
| | Organize and convey meaning of the practices of science and math used in art creation. | |
| | Compare and contrast the processes and practices involved in scientific, mathematical, and artistic activities. | |

Modifications While several students may be at a “laptop station” filling out their sheets, some students may need their own laptop and more personal space. Students may take laptop to their seat to see it better and some students will not need to answer all questions.

Standards Addressed

NGSS: NOS

Scientific Investigations Use a Variety of Methods

- Science depends on evaluating proposed explanations.
- Scientific values function as criteria in distinguishing between science and non-science

Science is a Way of Knowing

-Science is both a body of knowledge and the processes and practices used to add to that body of knowledge.

– Science knowledge is cumulative and many people, from many generations and nations, have contributed to science knowledge.

-Science is a way of knowing used by many people, not just scientists.

Art Standards: Presenting:

Anchor Standard #6 Convey meaning through artistic presentation of work

Students collaboratively examine and respond to a body of contemporary artworks in order to make interpretations of meaning conveyed through such works.

Interpreting and sharing artistic work

Common Core Math Practices:

6. Attend to precision.

7. Look for and make use of structure.

8. Look for and express regularity in repeated reasoning.

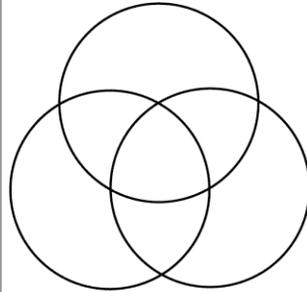
Formative/Summative Assessments: Formative assessment will be to see how much the student was able to fill out. There is also a question for what the students want to know. There is no summative assessment at this time.

Resources: Photographs will be from Nasa Art Program. There are 25 photos available to view.

<https://www.flickr.com/photos/nasacommons/sets/72157633977913266/with/8973492146/>

Worksheet with questions. Laptops to view art online.

Procedure: Students will make a 3 Circle Venn diagram of Who/ What is a Scientist and Who/What is an Artist and Who/What is a Mathematician This will be done with a small group, maximum four students. The teacher is available to answer questions and prompt students with questions if needed. Students may work in small groups.



Explain

Students will share their Venn diagrams with one other group to discuss differences and similarities.

Then I will share with them the chart below and they can add to their Venn Diagrams.

Common Processes in the Sciences and Arts

| In the Sciences... | Common Processes | In the Arts... |
|---------------------------|-------------------------|------------------------|
| Data collection | Noticing | Observation |
| Curiosity | Wondering | Imagination |
| Experimentation | Exploring | Rehearsal |
| Design | Visualizing | Composition |
| Explanation | Communicating | Performance/Exhibition |

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| | <p>The students will then add “In math” as a class we will look at the mathematical practices and create another column together.</p> <p>Modifications: Depending on need, students could choose the Venn diagram they want to do and do only one, choose group of who they want to work with, discuss instead of write down, and teacher can write ideas.</p> <p>Standards: NGSS NOS <u>Middle School</u>: <i>Scientific Knowledge is Open to Revision in Light of New Evidence-</i> -Scientific explanations are subject to revision and improvement in light of new evidence. -The certainty and durability of science findings varies. - Science findings are frequently revised and/or reinterpreted based on new evidence. <i>Science is a Human Endeavor</i> -Men and women from different social, cultural, and ethnic backgrounds work as scientists and engineers.</p> <p>Formative/Summative Assessments</p> <p>Students should check their “Self Evaluation of Objectives” to determine their understanding. When they feel they have met the objective, they can check it off. If they need help, they should ask teacher. Teacher can clarify objectives.</p> <p>Resources</p> <p>Copies of 3 Venn Diagram and Common Practices in Sciences and Arts</p> |
| <p><u>Elaborate</u> <i>Students may pick a piece of art to evaluate</i> .</p> | <p>Procedure: The teacher is explaining the assignment and providing a rubric. The student is listening and then will start the project either by themselves or with a partner or small group. The students will choose a piece of art to critique through the Nature of Science matrix. They must address:</p> |

Scientific Investigations Use a Variety of Methods
Scientific Knowledge is Based on Empirical Evidence
Scientific Knowledge is Open to Revision in Light of New Evidence
Scientific Models, Laws, Mechanisms, and Theories Explain Natural Phenomena
Science is a Way of Knowing
Scientific Knowledge Assumes an Order and Consistency in Natural Systems
Science is a Human Endeavor

To address these students will need to reference the Common Processes Chart so that they incorporate art and science.

For ASSIGNMENT: See bottom of this lesson plan:

Rubric:

Exhibition Narrative

Expert.....Novice

| | | |
|----------------------------------------------|--------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| Original Interpretation | Shows time and many perspectives coming together to create a cohesive idea. | Time spent was minimal or one person came up with the idea. |
| Researched Interpretation | Thoughtfully researched details of art that included time frame, societal issues, meaning, and deeper exploration. | Researched information that included the meaning of the art, but missing background influences. |
| Nature of Science | At least 4 topics are clearly addressed with examples of how the interpretation process is similar to NOS. | Less than 4 topics are integrated with examples of how the interpretation process is similar to NOS. |
| Practices and Processes Reflection Statement | Used Completed Chart to evaluate the similarities and describe actions of those processes and practices. | Limited practices and processes addressed. Some details given of similarities but connection not solid. |

Modifications: This can be done in small groups if needed so some students can share tasks and still be part of the project.

Standards Addressed:

Art Standards: Presenting:

Anchor Standard #6 Convey meaning through artistic presentation of work

Students collaboratively examine and respond to a body of contemporary artworks in order to make interpretations of meaning conveyed through such works.

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| | <p>Interpreting and sharing artistic work.</p> <p>Common Core Math Practices</p> <ol style="list-style-type: none">1. Make sense of problems and persevere in solving them.2. Reason abstractly and quantitatively.3. Construct viable arguments and critique the reasoning of others. <p>Formative/Summative Assessments The only assessment I will be using at this time is to watch and listen to groups and students. I will be making sure that everyone is participating and having an opportunity to share their ideas. By listening I will be able to gain an understanding of where the students are at with connecting science, art, and math practices and processes.</p> <p>Resources Students may need computers to research a piece of art. In addition, old calendars and art magazines can be used.</p> |
| <p><u>Evaluate</u></p> <p><i>A gallery walk or presentation will allow students to showcase and explain their critique/ reflection.</i></p> | <p>Procedure: Students will present their art and reflection to the class through a gallery walk. Students and teacher should be active listening.</p> <p>Modifications:</p> <p>Some students may not feel comfortable presenting, so I will let them present only to me, or present with a partner. Students may also videotape themselves presenting and share it with teacher.</p> <p>Standards Addressed NGSS NOS</p> <p><i>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</i></p> |

-Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation.

-Science carefully considers and evaluates anomalies in data and evidence.

Art Standards:

Responding:

Anchor Standard #9 Apply criteria to evaluate artistic work

Students collaboratively exhibit their work and develop an exhibition narrative to guide viewers.

Formative/Summative Assessments During the gallery walk, Students will need to identify which of the NGSS NOS is relevant to the art and art reflection. They will also need to make a statement that ties in the processes and practices of math and art to science. This will show a new way of thinking for the students. This is a summative assessment.

Students and Teacher will also need to fill out objective rubric:

| The Visual Arts in the Nature of Science | | |
|------------------------------------------|-----------------------------------------------------------------------------------------------------------------|--------------------|
| Self Evaluation | Objective | Teacher Evaluation |
| | Analyze a piece of art by using and applying the standards of Nature of Science | |
| | Exhibit their work and develop an exhibition narrative to guide viewers | |
| | Apply criteria to observe art and reflect upon art. | |
| | Organize and convey meaning of the practices of science and math used in art creation. | |
| | Compare and contrast the processes and practices involved in scientific, mathematical, and artistic activities. | |

Resources: Student(group) selected art. Large paper to “Frame” Computers to write statements.

Teacher Background:

Analysis of Art piece : <https://www.fridakahlo.org/self-portrait-with-thorn-necklace-and-hummingbird.jsp>

NASA and Art: A Collaboration Colored with History

<https://www.nasa.gov/feature/nasa-and-art-a-collaboration-colored-with-history>

Sources:

APPENDIX L – Connections to the Common Core State Standards for Mathematics 1. (2013, June 3). Retrieved

from: <https://www.nextgenscience.org/sites/default/files/Appendix->

[L_CCSS%20Math%20Connections%2006_03_13.pdf](https://www.nextgenscience.org/sites/default/files/Appendix-L_CCSS%20Math%20Connections%2006_03_13.pdf)

Fulton, L. A., & Simpson-Steele, J. (2016). Reconciling the Divide: Common Processes in Science and Arts Education. *The STEAM Journal*, 2(2), 3.

National Core Arts Standards: <http://www.nationalartsstandards.org/>

The Nature of Science in The Next Generation Science Standards. (2013, April 3).

Retrieved from: <https://www.nextgenscience.org/sites/default/files/Appendix%20H%20->

[%20The%20Nature%20of%20Science%20in%20the%20Next%20Generation%20Science%20Standards%204.15.13.pdf](https://www.nextgenscience.org/sites/default/files/Appendix%20H%20-%20The%20Nature%20of%20Science%20in%20the%20Next%20Generation%20Science%20Standards%204.15.13.pdf)

Assignment Guidelines for Art and Exhibition Narrative:

Exhibition Narrative to Guide Viewers:

Name(s)_____pd._____

Pick a piece of art to evaluate with your group. This is your summative assessment for The Visual Arts in the Nature of Science. This will be typed and printed to be presented alongside your piece of art as you collaboratively exhibit your Art and Exhibition Narrative.

Name of Art:

Artist:

Year Created:

1. Collaboratively examine your art and make an interpretation of the meaning through your chosen art piece:
2. Write a paragraph that combines your original interpretation as a group. Research your art to then relate artistic ideas and works with the societal, cultural, and historical context of the piece to deepen the understanding for your viewers.
3. Write a reflection statement about the integration of math, science, art practices and processes.
4. Write a paragraph addressing the similarities of the nature of science to interpreting a piece of art: (Use at least four of the following:)

Scientific Investigations Use a Variety of Methods

-Science investigations use a variety of methods and tools to make measurements and observations.

-Science investigations are guided by a set of values to ensure accuracy of measurements, observations, and objectivity of findings.

- Science depends on evaluating proposed explanations.
- Scientific values function as criteria in distinguishing between science and non-science

Science is a Way of Knowing

- Science is both a body of knowledge and the processes and practices used to add to that body of knowledge.
 - Science knowledge is cumulative and many people, from many generations and nations, have contributed to science knowledge.
- Science is a way of knowing used by many people, not just scientists.

Scientific Knowledge is Open to Revision in Light of New Evidence

- Scientific explanations are subject to revision and improvement in light of new evidence.
- The certainty and durability of science findings varies.
- Science findings are frequently revised and/or reinterpreted based on new evidence.

Science is a Human Endeavor

- Men and women from different social, cultural, and ethnic backgrounds work as scientists and engineers.

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation.
- Science carefully considers and evaluates anomalies in data and evidence.

Endeavor STEM Teaching Certificate Project
Visual Arts in the Nature of Science, Hilary Penner
July 21, 2020