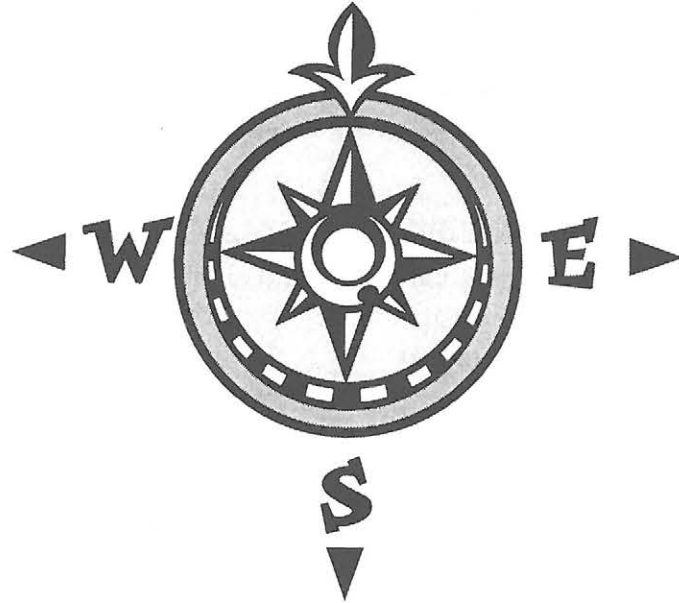


UNIT 2:

NATHANIEL BOWDITCH AS MATHEMATICIAN



Overview for Teachers

Unit Outline

Introduction:

Nathaniel Bowditch was a mathematician, an astronomer, a navigator, and an actuary. Mathematics and science were the center of his life in post-American Revolutionary Salem. At the time of his death in 1838, Nathaniel had earned membership into most of the scientific societies of the world:

- American Academy of Arts and Sciences, Boston (President)
- American Philosophical Society, Philadelphia
- Connecticut Academy of Arts and Sciences, New Haven
- Royal Society of London (England)
- Royal Irish Academy, Dublin (Ireland)
- Salem Marine Society, Salem, MA
- Royal Astronomical Society, London (England)
- Royal Academy of Palermo (Italy)
- Royal Academy of Berlin (Germany)

Nathaniel's genius was not necessarily in his new discoveries in math and science, but his gift for explaining complex subjects in terms understandable to the average citizen. His scientific writings were reviews and revisions of other, more complex texts. Bowditch would characteristically add additional tables, drawings, and explanations to improve the clarity and presentation of the original document.

Additionally, Nathaniel Bowditch the mathematician is seen in navigation circle as an unheralded genius, an important contributor to American freedom through sea power (Hubbard, 2000). Bowditch's *New American Practical Navigator* saved uncountable ships from certain destruction and insured arrival swiftly to port. This was all due to an advanced mathematical ability and scientific acuity.

The following lesson allows students to "put on a mathematician's shoes" to experience life as both a mathematician and an individual in the 18th or 19th century. Many prominent mathematical scholars are introduced for student research and characterization.

Objectives:

- Students will experience life as both a mathematician and an individual in the 18th or 19th century by "putting on mathematician's shoes."

Skills:

- Students will understand and apply scales.
- Students will use scale to develop a time line
- Students will sequence mathematicians' life times
- Students will research the contributions of famous mathematicians

Vocabulary:

- proportion

Frameworks Connections: Mathematics

Mathematics:

Strand 2: Patterns, relations and functions

- Describe, extend, create a wide variety of patterns, 2.4, p. 60

Science and Technology:

Strand 1: Inquiry

- Note and describe relevant details, patterns, relationships, p.28

Strand 2: Domains of Science, Life Sciences

- Present evidence on how one species depends on another, p. 63

History and Social Science:

Strand 1: History

Standard 1: Chronology and cause

- Understand chronological order of historical events, p. 78
- Understand meaning, implications, importance of historical events, p. 79.

Standard 3: Research, evidence, and point of view

- Acquire ability to frame questions that can be answered by historical study, p. 84

Standard 6: Interdisciplinary Learning: Natural Science, Mathematics and Technology in History

- Will describe and explain major advances over time, p. 92

Unit 2 Lesson Plans



Lesson 1: Nathaniel Bowditch as Mathematician

Objective:

- Students will experience life as both a mathematician and an individual in the 18th or 19th century by "putting on mathematician's shoes".

Skills:

- Students will need to develop a scale for their timeline.

Vocabulary:

- Proportion

Materials:

- Black line master tree cross section as an overhead transparency
- Time Line Directions for Activity 1 - handout
- Discussion Questions for Activity 2 - handout
- List of 18th Century and 19th Century mathematicians
- Name cards cut from black line master
- Long strips of paper (adding machine tape from old adding machines)
- Pencils, markers, rulers

Procedure:

Activity 1: Tree Ring Birthday and Time-Line Building

- Use the black line master of the tree trunk cross section to make one or two overhead transparencies. The projection must be large enough to estimate the location of the tree rings that correspond to the mathematician's birthday. If you make two transparencies, use one cross-section for each century. [Option 2: Use the black line master to have an enlarged poster size tree trunk made at a graphics studio.]
- Photocopy the names of the mathematicians onto a 60 pound weight card stock paper or similar weight paper. Cut out the strips of names on cut lines placing the strips into a basket or hat for students to draw their mathematician's name. Distribute the names to students. If you wish to use only selected names, we suggest that you choose mathematicians in the same century.

- Each group should have one roll of adding machine tape. Groups will need pencils, at least one marker, one or two rulers, and a sheet of directions for making a time line (included in this guide).
- Student groups go to the tree trunk on the transparency wall or poster and place their mathematician's name at a tree ring corresponding to the mathematician's birthday. Assume one tree was planted in 1700 and the other tree planted in 1800.
- While one group is at the tree cross section, the rest of the groups are deciding where their mathematician would be placed and starting the adding machine time line (see Time Line Directions for Activity 1).

Activity 2: Research

Materials:

- Name cards cut from black line master
- Optional: students dress in period attire
- Discussion Questions for Activity 2.

Prepare before the lesson:

Assemble biographies of the mathematicians from either the listed websites, the AIMS resource books, or from other library sources. Students can prepare these biographies themselves after they choose their mathematician's name. This can happen during class time or as a homework assignment.

Procedure:

Cooperative Groups: After students have selected their names, they go to the cooperative group listing the appropriate century for the person's birth date. No more than five students are allowed in any one group. The students will first read about the mathematician that they chose and then respond to discussion questions on the Discussion Questions for Activity 2 provided with this lesson.

Allow 15 minutes for the groups to complete the Discussion Questions for Activity 2. The selected speaker from each group will then share the group's research findings with the rest of the class.



TIME LINE DIRECTIONS FOR ACTIVITY 1:

1. Your time line will cover a 100 year period. Create a scale for your time line so that all of the mathematicians in your group will fit the time line even though the dates may be between the inch marks.

Do your calculations here:

2. After you have decided how long your time line will be, unroll the correct amount from the adding machine roll.
3. Draw a line lengthwise down the center of the tape.
4. Draw the inch marks. Label the years that each inch mark represents (use the scale your group calculated in step 1).
3. Place the mathematician's name cards on the time line at their year of birth.
5. If your group finishes early, discuss how the mathematicians may have talked to each other.
6. If _____ had communicated with _____, how might that have changed their thinking?
7. Example: If Nathaniel Bowditch could have spoken to Isaac Newton, how would Bowditch's thinking have changed?
8. What topics would they have discussed?
9. How would they have communicated? by phone? by mail?

Write your ideas in the space below:



DISCUSSION QUESTIONS FOR ACTIVITY 2:

1. List the mathematicians in your group in the chart below. Write a brief description about the work of each. Use one or more of these words as a category for the mathematician's work: geometry, algebra, number patterns, physics applications, statistics.

2. Did any of these mathematicians live during the same time? Write the names and the ages of each of your mathematicians at the time when Nathaniel Bowditch was born in 1773.

3. If your group finishes early, talk about how the mathematicians may have talked to each other.

What topics would they have discussed?

How would they have communicated?

Write your ideas in the space below. Use the back of this sheet if you need more room.

4. If any mathematician had already died, what did the current mathematicians probably learn from his/her earlier work?



RUBRIC FOR TEACHERS TO RATE GROUP ACTIVITY

Time Line

Mathematician's Name	Nationality, Date of Birth Date of Death	Category of Major Work	Brief Description of Work

Name	Age when Bowditch was born

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UNIT
2
STUDENT
HANDOUT



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MATHEMATICIANS FROM THE 18TH & 19TH CENTURY

18th Century	19th Century
18th Century	19th Century

Choose mathematicians from these 18th century or 19th century mathematicians. Add others if you wish.

Joseph-Louis Lagrange 1736 - 1813	George Simon Ohm 1789 - 1854	Ludwig Otto Hesse 1811 - 1874
Mary Fairfax Somerville 1780 - 1872	August Ferdinand Mobius 1790 - 1868	Robert Woodhouse 1773 - 1827
Caroline Herschel 1750 - 1848	Charles Babbage 1792 - 1871	Carl Gustav Jacob Jacobi 1804 - 1851
Marie-Sophie Germain 1776 - 1831	Olinde Rodrigues 1794 - 1851	Evariste Galois 1811 - 1832
Benjamin Banneker 1731 - 1806	Johann Christian Doppler 1803 - 1853	George Boole 1815 - 1864
Leonhard Euler 1707 - 1783	Pierre Simon Laplace 1749 - 1827	Jules Antoine Lissajous 1822 - 1880
Nathaniel Bowditch 1773 - 1838	Ruan Yuan 1764 - 1849	Fofia Kovalevskaya 1850 - 1891
Sir Isaac Newton 1643 - 1727	Maria Gaetanna Agnesi 1718 - 1799	Ada Byron Lovelace 1815 - 1852
Carl Frederich Gauss 1777 - 1855	Jean Bernoulli 1744 - 1807	Florence Nightingale 1820 - 1910
Furukawa Ken 1783 - 1838	Wada Yenzo Nei 1787 - 1840	Mary Everest Boole 1832 - 1916
Nicolai Ivanovich Lobachevsky 1792 - 1856	George Peacock 1791 - 1858	John Wilson 1741 - 1793

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EXTENSION ACTIVITY IDEAS

1. Students can pair up and interview each other as their mathematician talking across centuries. Pair students by common math ideas after reading biographies.
2. Students can write an interview with their own mathematician and create newspaper articles for a class publication. Students can name the newspaper and design the masthead.
3. Students can find major historical events occurring at the same time period and place these on cards for the time line.
4. Students can identify literary writers, artists and presidents living during their time line period, and create cards for each to place on the time line.
5. Students can research other important Salem citizens and place their name on cards for the time line.



RUBRIC FOR TEACHERS TO RATE GROUP ACTIVITY

Assessment objectives	1 Excellent	2 Good	3 Fair	4 Poor
1. Students agreed on a time scale				
2. Students completed the time line				
3. Students correctly placed names on time line				
4. Students completed the group sheet				
5. Students reported to class				
6. All students participated in activity				

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