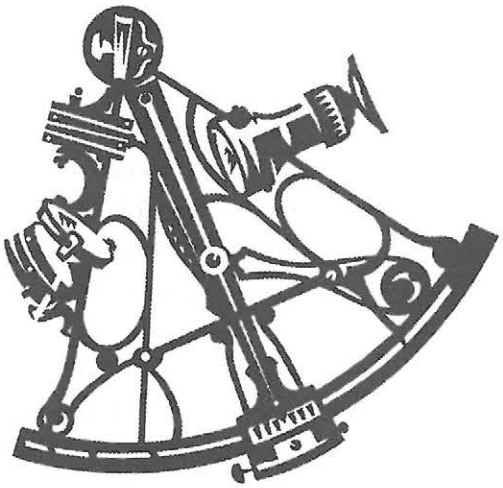
Unit 1:

NATHANIEL BOWDITCH



Overview for Teachers

Unit Outline

Introduction

Nathaniel Bowditch (1773-1838) was one of Salem's outstanding scientific minds and respected citizens. His father, Habakkuk, was frequently destitute. The Bowditch children had few warm coats and were left to wear their summer shirts and jackets in the cold New England winter. On several occasions other children would taunt Nathaniel and his siblings. His response was to laugh back, assuming they were unable to stand the cold Salem weather.

At the age of twelve Nathaniel was indentured to Ropes and Hodges Ship Chandlery. This indentureship lasted for nine years. Although a formal education was now denied him, Nat taught himself mathematics, astronomy, navigation, Latin, and French. In addition, the outstanding scientific library of the Salem Philosophical Society was made available to him by an invitation from Dr. William Bentley, a minister and well-respected scholar in Salem. Nathaniel took great advantage of this opportunity to improve his education even more.

Nathaniel made four voyages as the captain's clerk and supercargo between 1795 and 1803. He studied the science of calculating longitude by determining the moon's position. After making countless observations and calculations, Bowditch discovered over 8,000 errors in Moore's standard British navigational tables. In 1802 he published a revised version called *The New American Practical Navigator.* His book was the crowning achievement of numerous successful endeavors. The book has been translated into a dozen languages and has remained the sailor's bible through 75 editions. No sailor in his right mind would go to sea without his "Bowditch".

Nathaniel's extraordinary navigation skills were known throughout the Salem maritime community. The successful voyage of *The Putnam* is a testimonial to his skill and mathematical confidence. On Christmas day in 1803, *The Putnam* was lying off the coast of Massachusetts. Only miles from Derby Wharf, the ship was trapped in a thick fog bank. The approach to Salem harbor was filled with numerous small islands and hidden ledges. On a clear day navigation was hazardous; dense fog was impassable. Other captains anchored and waited for the weather to clear. Nathaniel, now Captain and part-owner of *The Putnam,* trusted his mathematics and his knowledge of the harbor to bring his ship home to Salem. Nathaniel had only two readings at the sun with his sextant , pinpointing his approximate location in Massachusetts Bay. With this information, a compass, and accurate charts of the harbors' approaches, Bowditch felt confident he could get *The Putnam* safely home and in time for Christmas.

Bowditch used time-honored methods of log and line to calculate *The Putnam's* speed and lead lines to verify the water's depth. As *The Putnam* entered the harbor she passed Bowditch's Ledge. Legend had it that it was named for an ancestor of Bowditch who had sunk a vessel on it. He saw the faint light of the lighthouse on Baker's Island. *The Putnam* soon passed a familiar sight, Winter Island, and suddenly the crew of *The Putnam* was home safe and sound. Bowditch's unshakable faith in his own calculations proved that with accurate mathematics, one could go almost anywhere practically blindfolded.

The people of Salem could not believe their eyes when Bowditch, wet and gaunt came walking through the dark and foggy Christmas night. This seemingly miraculous feat of navigation made Bowditch a living legend in maritime circles. At his death, the Boston Marine Society paid the following tribute to Nathaniel Bowditch: *His intuitive mind sought and amassed knowledge, to impart it to the world in more easy forms.*

Salem Merchants

The port of Salem built its fortunes on the eastern luxuries trade during the late 18th and early 19th centuries. The shipping of necessities was a secondary business in Salem. Dozens of goods were exchanged between Salem and the Orient. A typical Salem East Indiaman left the wharf with cod, tobacco, leather, candles, pork, shoes, lumber, hats, furniture, butter, beef, cloth, cheese, onions, European hardware and American rum. On the return voyage, Yankee captains like Bowditch obtained tea and fine silks from China, coffee from Arabia, pepper from Sumatra and cotton textiles from distant India. In addition, they often increased their profits by obtaining ivory, wine, and gold dust from Africa. Spices such as ginger, cinnamon and cloves were obtained from the Spice Islands (East Indies). Few captains engaged directly in the slave trade, however their indirect involvement came from providing the slave plantations with goods.

The profits of this world trade were often distributed through the community. For example, Elias Hasket Derby, a very wealthy shipowner, allowed his apprentices to put their savings into small "ventures" in foreign trade. He gave them each space on his vessels for the new ventures. Nathaniel Bowditch got his start in foreign trade with Derby's assistance.

Objectives:

- Students will understand terminology important to the Salem maritime merchants.
- Students will retrace the voyages of Nathaniel Bowditch.
- Students will investigate the history/geography/economics of the voyages.
- Students will analyze the contribution of the Salem craftsmen to the success of the seaport.
- Student will learn to judge the process of building a wooden vessel during Nathaniel Bowditch's time.

Skills:

- Students will develop economic reasoning skills.
- Students will learn to judge cause and effect in historical and economic contexts.
- Students will understand the skills needed to become proficient craftsmen, and in particular, boat builders.

Vocabulary:

- barter
- export
- import
- venture
- supercargo
- apprentice
- foreign
- seaman
- luxuries
- Yankee
- cobbler
- barber
- blacksmith
- pewter
- tanner
- silversmith
- cabinetmaker
- miller
- cooper
- whitesmith
- shipwright
- joiner
- caulker
- half-model
- keel
- stem & stern posts
- trunnels
- teredo worms

Frameworks connections:

History and Social Science:

Strand 1: History

Standard 1: Chronology and Cause, p. 79

Standard 2: Historical Understanding, p. 2

Standard 6: Interdisciplinary Learning, p. 93

Strand 2: Geography

Standard 7: Physical spaces of the earth, p. 94

Standard 8: Places and regions of the world, p. 96

Standard 9: The effects of geography, pp. 98-100

Strand 3: Economics

Standard 12: Economic reasoning, p. 108

Standard 13: American and Massachusetts Economic History, p. 111

Unit 1 Lesson Plans

Lesson 1: Nathaniel Bowditch and Salem

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- Students will understand terminology important to the Salem marine merchants.
- Students will retrace the voyages of Nathaniel Bowditch.
- Students will investigate the history/geography/economics of the voyages.

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- apprentice
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- seaman
- luxuries
- Yankee

Materials:

- Nathaniel Bowditch – handout
- Salem Merchants – handout
- Terms to Know – handout
- World Geography - handout
- World Map with scale
- Colored Pencils
- Map of South East Asia
- Geography/History – handout
- The Voyages of Nathaniel Bowditch

Procedure:

1. Read the handouts, entitled Nathaniel Bowditch and Salem Merchants.
2. Answer the questions following the reading.
3. Research the definitions on the Terms to Know handout.

Group Activity

4. Retrace the voyages of Nathaniel Bowditch by following the steps listed in the handout, World Geography.

5. Answer the questions on the voyages of Bowditch, Geography/History handout.

Independent Research

6. A captain like Nathaniel Bowditch had many navigational tools to help him pinpoint his exact location. Choose one of the following navigational tools and prepare an oral report on the history and the significance of the tool.

- astrolabe
- celestial almanac
- chronometer
- compass
- octant
- sextant
- telescope

UNIT 1 STUDENT HANDOUT

NATHANIEL BOWDITCH

Nathaniel Bowditch (1773-1838) was one of Salem's outstanding scientific minds and respected citizens. His father, Habakkuk, was frequently destitute. The Bowditch children had few warm coats and were left to wear their summer shirts and jackets in the cold New England winter. On several occasions other children would taunt Nathaniel and his siblings. His response was to laugh back, assuming they were unable to stand the cold Salem weather.

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bor was filled with numerous small islands and hidden ledges. On a clear day navigation was hazardous; dense fog was impassable. Other captains anchored and waited for the weather to clear. Nathaniel, now Captain and part-owner of *The Putnam*, trusted his mathematics and his knowledge of the harbor to bring his ship home to Salem. Nathaniel had only two readings at the sun with his sextant , pinpointing his approximate location in Massachusetts Bay. With this information, a compass, and accurate charts of the harbors' approaches, Bowditch felt confident he could get *The Putnam* safely home and in time for Christmas.

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UNIT 1 STUDENT HANDOUT

SALEM MERCHANTS

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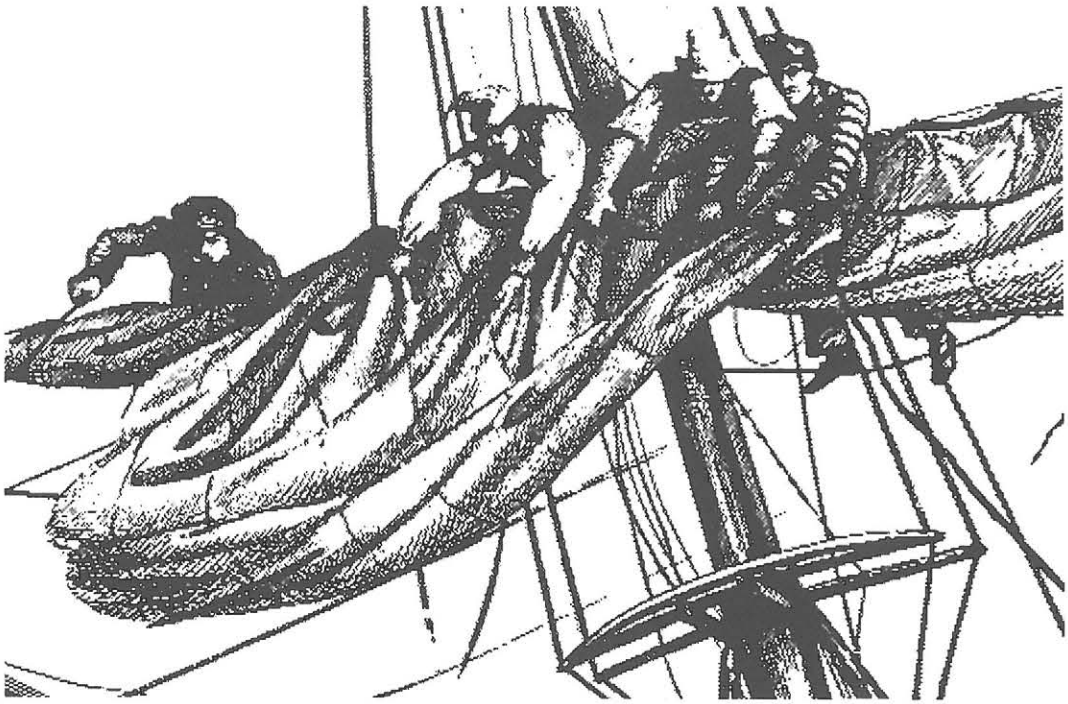


THE LIFE OF NATHANIEL BOWDITCH

1. How old was Nathaniel Bowditch when he died?
2. Describe Nathaniel's family when he was a child.
3. What did Nathaniel have to wear in the cold New England winters?
4. Between 1795-1803 how many sea voyages did Nathaniel Bowditch undertake?
5. How many errors did Bowditch discover in Moore's standard British navigational tables?
6. In what year did Bowditch publish his book, *The New American Practical Navigator*?
7. How many languages was his book translated into?
8. What nickname did sailors give his book?
9. What was the name of the ship in which Bowditch was captain?
10. On what day did Bowditch return home to Salem on a ship in 1803?
11. What tools did Bowditch use to guide his ship safely into Salem harbor? Name all five.
12. What were the weather conditions like when Bowditch navigated into Salem harbor?
13. Explain in your own words the following quote about Bowditch: *His intuitive mind sought and amassed knowledge, to impart it to the world in more easy forms.*

Retrace the Voyages of Nathaniel Bowditch

1. Choose five colored pencils. Assign a different color to each voyage.
2. Create a color key.
3. Locate and place Bowditch's destinations on your world map. (Don't forget Salem)
4. Now that you have chosen your colors proceed to retrace each of Bowditch's five voyages (see handout).
5. Locate and place all the oceans that Bowditch sailed across in his journey.
6. Label the Equator and the Tropics of Cancer and Capricorn.
7. Label the seven continents.
8. Label the mileage of each of Bowditch's voyages from Salem.
9. Label all ten seas found in South East Asia.
10. Label all current nations of South East Asia.

Materials needed:

1. Color pencils
2. World map w/scale
3. Map of South East Asia
4. World atlas
5. The Voyages of Nathaniel Bowditch - handout

Questions on the Voyages of Bowditch

1. Did Bowditch cross the equator during his third voyage?
2. Define Supercargo.
3. In Bowditch's time Jakarta, Indonesia was known as _____?
4. In what body of water is Réunion Island?
5. What was Réunion Island called during Bowditch's visit?
6. What country claims ownership of Réunion Island?
7. During the American Revolution, was this country on the American or British side?
8. What country did Bowditch visit during his third voyage?
9. What is the native language spoken in Cadiz?
10. What European colonial power controlled Batavia during Bowditch's visit on his fourth voyage?
11. Which continent is Indonesia a part of?
12. Indonesia today is ranked as the _____ most populated country?
13. What is the population of Indonesia today?
14. List the three spices found by merchants in Indonesia.

    1. 2. 3.

15. List several natural resources found in Indonesia today.

UNIT 1 STUDENT HANDOUT

THE VOYAGES OF NATHANIEL BOWDITCH

	Ship	Dates	Destination
I.	**The Henry**	1/11/1795- 1/11/1796	Isle of Bourbon (Réunion) Isle of France (Mauritius)
II.	**The Astrea**	3/15/1796- 5/22/1797	Lisbon, Portugal Manila, Philippines
III.	**The Astrea**	8/21/1798- 4/16/1799	Alicante and Cadiz, Spain
IV.	**The Astrea**	7/23/1799- 9/15/1800	Batavia (Jakarta, Indonesia) and Manila
V.	**The Putnam**	11/21/1802- 12/25/1803	Sumatra, Indonesia

TERMS TO KNOW

Look up the definition of the following terms.

1. Barter -

2. Export –

3. Import –

4. Venture –

5. Supercargo –

6. Apprentice –

7. Foreign –

8. Seaman-

9. Luxuries-

10. Yankee –

Lesson 2: Tools of the Trade

Objectives:

- Students will investigate and describe the uses of the sextant, the pendulum, the sundial, the quadrant, and the astrolabe.

Skills:

- Students will develop independent research skills
- Students will utilize a variety of print and electronic media, including the Internet and the library.

Vocabulary:

- Sextant
- Pendulum
- Sundial
- Quadrant
- Astrolabe

Materials:

- Background information – Sextant, Pendulum, Quadrant, Astrolabe, and Sundial – handout
- Pattern for a three dimensional cube - handout

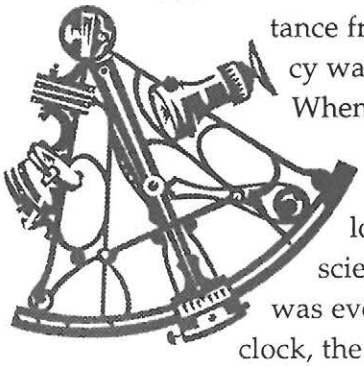
Procedure:

1. Your task is to research 5 navigational instruments used during Nathaniel Bowditch's time: the sextant, the pendulum, the sundial, the quadrant, and the astrolabe. Some are actual navigational instruments; others were used as the framework for the instrument.
2. Research both the history and uses of each instrument. Include the earliest use, it's use during Bowditch's lifetime (1773-1838), and modern applications.
3. Include a diagram or picture of each instrument.
4. List all references, both print media and Internet.
5. Enlarge the pattern for a three dimensional cube to make a larger block.
6. Your research for each of the five instruments should include your name at the top of the first page, and a bibliography in the back.

Background Information:

Sextant, Pendulum, Quadrant, Astrolabe, and Sundial

Sextant: an optical instrument used for measuring the angular distance between any two objects. The English mathematician John Hadley and the American inventor Thomas Godfrey invented it about 1730. The navigator can measure the angular elevation of the sun and other celestial bodies and from this information calculate latitude and longitude. The optical system consists of a telescope and two mirrors, one fixed and one moveable. In the diagram, the telescope is mounted in a fixed position on the body of the instrument pointing toward the mirror; the top half of this mirror is transparent and the bottom half is silvered. A second mirror is angled above the first. An observer looks through the telescope and sees the horizon through the unsilvered portion of the mirror and at the same time sees the image of the star or the sun on the silvered portion as re-reflected from the second mirror. A sextant reading can be obtained that is double the actual altitude of the star.



The sextant allows you to determine latitude, or north/south distance from the equator, with accuracy. The same accuracy was needed for longitude, or the east/west distance. When a fleet of four ships ran aground in the fog and killed 2000 men, a large sum of money was offered as a prize for finding a way to calculate longitude. Isaac Newton was one of the famous scientists who tried to find a method. The problem was eventually solved by John Harrison with an accurate clock, the chronometer. By measuring the difference in local time versus the Greenwich time, you can calculate the distance east/west.

Pendulum

In 1657 the Dutch physicist Christian Huygens demonstrated how a pendulum could be used to regulate a clock. In 1667 the English physicist Robert Hooke invented an escapement that allowed a smaller arc of oscillation. This escapement was improved upon by British clockmaker George Graham. John Harrison, the inventor of the chronometer, developed a means to compensate for a variation in the length of the pendulum due to temperature change.

Quadrant

The sum of the height of the observer plus the product of the Tan(angle) and the distance the object is from the observer = height of the object.

If the angle is 45, then the height of the object is equal to the distance the observer is from the object

Sundial

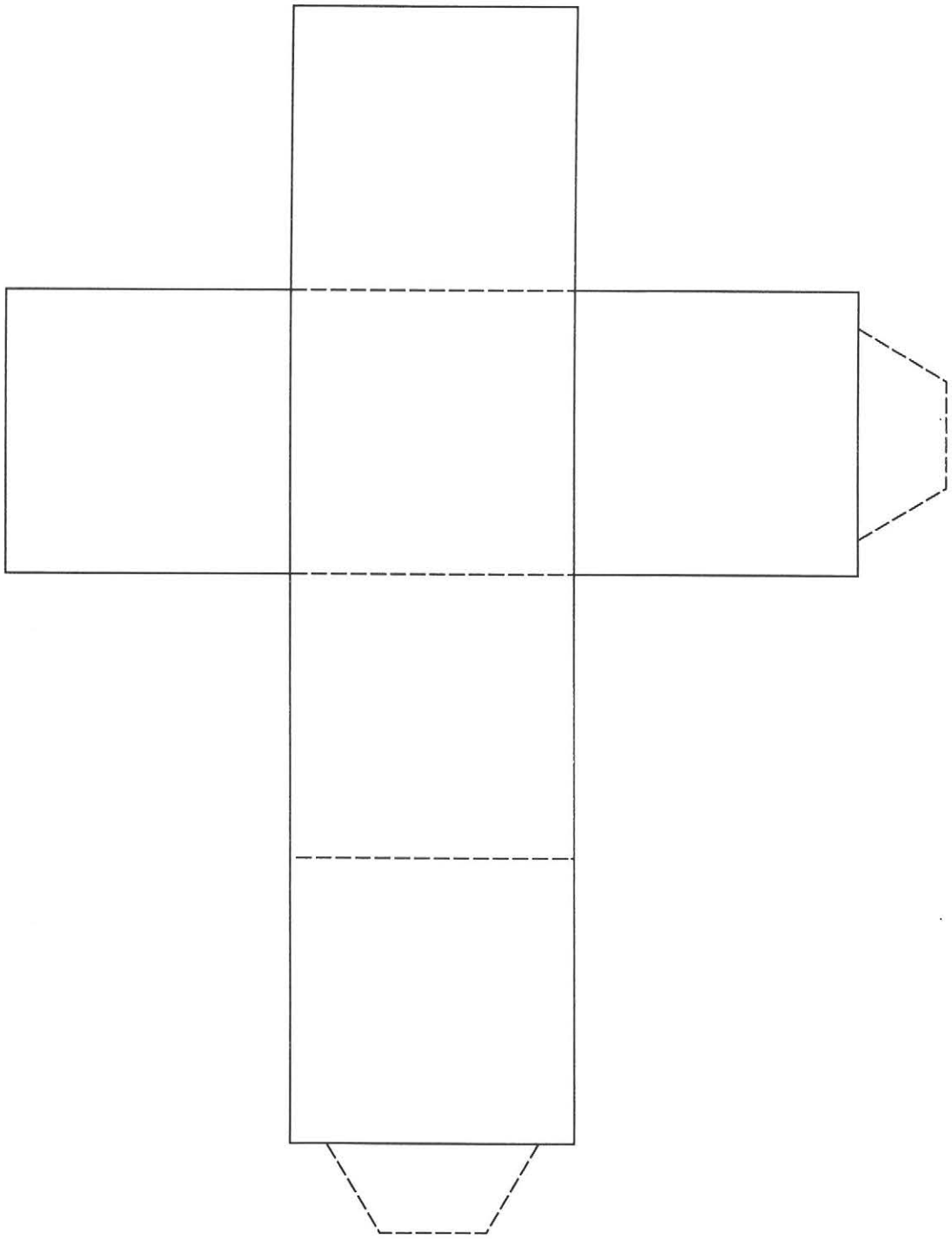
Until the end of the 19th century, all time was local and related to the sun. In 1884 an international convention was held in Washington, DC to agree on a world wide system of time. A sundial consists of a dial plate which is marked with hour lines and a "gnomon", a projection that casts a shadow. The inclined edge of the gnomon is called the style; it is oriented parallel to the Earth's axis and points to a celestial location close to Polaris. Directions for making a sundial can be found at http://cpcug.org/user/jaubert/jsundial.html.

Astrolabe

Astrolabes have been traced to the 6th century and came into wider use in Europe and the Islamic World during the Middle Ages. By mid 15th century, the astrolabe was adopted by mariners and used in celestial navigation. The mariner's astrolabe was replaced by the sextant. Typically, a sailor would identify the constellations visible in the sky around the sun at sunrise. At noon, the sailor would hold the astrolabe waist high and record how many degrees the sun is above the horizon. Using the data from both observations and the Rules for the Astrolabe, the sailor could look up the latitude of the ship.

UNIT 1 STUDENT HANDOUT

PATTERN FOR 3D BOX



Lesson 3: Craftsmen of Salem:

Objectives:

- Students will understand the support system for the Salem economy provided by the local craftsmen.

Skills:

- Students will relate nautical terms to occupations.

Vocabulary:

- cobbler
- barber
- blacksmith
- pewter
- tanner
- silversmith
- cabinetmaker
- miller
- cooper
- whitesmith
- shipwright

Materials:

- Craftsmen of Salem – handout #1
- Craftsmen of Salem – handout #2
- Glossary of Sea Terms

Procedure:

1. Read Craftsmen of Salem #1
2. Complete the handout, Craftsmen of Salem #2

Group Activity:

3. Create flashcards with words and definitions of the glossary of sea terms words.
4. Challenge each group to design a board game utilizing the glossary words and the craftsmen labels.

CRAFTSMEN OF SALEM #1

The Craftsmen of Salem were critical to the success of its merchants. This group of highly skilled tradesmen supplied the merchants with finished products that could be exchanged for the luxury goods obtained from ports all over the world. They were also instrumental in building and outfitting the Salem ships. For example, an East Indiaman slipping through the harbor was the result of a highly cooperative enterprise. The skills of at least 20 craftsmen were displayed in the finished vessel.

Salem possessed numerous shipyards during Bowditch's lifetime. Shipbuilders turned out mostly small fishing and coasting vessels. Salem did not build the largest vessels, but its East Indiamen, heavily armed merchant ships built for the East India trade, were equal to any in quality. East Indiamen, like those sailed by Bowditch during his voyages, were built at the boat yards located near the mouth of the South River. The Briggs'shipyard is located on Stage Point, where the present day Shetland facility stands. Another important shipyard was Beckets located on the outer harbor. Beckets was founded in the mid-17th century and was one of the earliest boat yards in Salem. It was owned by the Becket family and located at the foot of Becket Street, near the present-day power plant.

Some shipbuilders owned other businesses. The Briggs family owned a rope-walk to ensure an adequate supply of cordage for their shipbuilding endeavors. The rope-walk was located over pilings jutting out from present-day Briggs Street over Collins Cove.

During his indenture at the Ropes and Hodges Ship Chandlery (1785-94) Nathaniel learned all there was to know about the supplying of ships. In seaports, a chandlery provided everything a ship could possibly need from rope to marlin spikes and barrels of hard-tack. In this capacity the young Bowditch frequently conversed with the craftsmen and vendors of various nautical goods. This experience was to become crucial to his later success as a supercargo, and later as a captain or merchant.

CRAFTSMEN OF SALEM #1

Below is a list and description of tradesmen found in Salem during Bowditch's lifetime. Match the following trades to their description.

A. Cobbler	1. A person who makes leather goods.
B. Barber	2. A person who builds ships.
C. Blacksmith	3. A person who makes barrels for storage.
D. Pewter	4. A person who makes or repairs shoes.
E. Tanner	5. A person who makes furniture.
F. Silversmith	6. A person who makes wigs.
G. Cabinetmaker	7. A person who makes and repairs items of tin.
H. Miller	8. A person who makes nails and other items of iron .
I. Cooper	9. A person who grinds wheat into flour.
J. Whitesmith	10. A person who makes expensive dinnerware.
K. Shipwright	

Lesson 4. Building A Wooden Ship.

Objectives:

- Student will examine the process of building a wooden vessel during Nathaniel Bowditch's time.

Skills:

- Students will understand the skills need to become proficient craftsmen, and in particular, boat builders.

Vocabulary:

- Half-model
- Mold-loft
- Brad axe
- Adze
- Joiners
- Keel
- Frames
- Hull
- Stem and stern posts
- Caulkers
- Teredo worms
- Copper sheathing

Materials:

- Building a Wooden Ship – handout
- Building a Wooden Ship – questions.

Procedure:

1. Read building a Wooden Ship
2. Answer the questions in the handout.
3. Arrange field trips to the many Essex County ships and boat building sites.

BUILDING A WOODEN SHIP

The creation of a wooden sailing ship such as Bowditch's *Putnam* began with a "half-model" or "lift-model". The process was accomplished by carpenters in an area called the "mold loft". The half model was separated into sections on the mold loft floor. The shape of the model was transferred to patterns or templates. Workmen shaped the frames of the ship with broad axes and adzes, using the patterns as guides. Natural curves of trees formed specific parts of the vessel's frame. Two favored woods for the frame and hull were white oak and live oak. These were favored for boat building due to their resistance to rot. Masts and spars, usually made of white pine, were pickled in saltwater ponds to both preserve them and to increase their resilience.

Carpenters, known as joiners, laid the keel, the great spine of the ship running along the bottom of the hull. The keel was fashioned from two or more pieces of wood "scarfed" together. The stem and stern post were then attached to the finished keel, which was lying on large blocks. The giant ribs of the ship, the frames, were raised next. The frames, together with the horizontal deck beams and the vertical stanchions, formed the contours of the hull. Together they provided a strong skeleton. All of these parts were held together by large wooden nails, or "trunnels". Trunnels were eventually replaced by bolts and spikes made from iron and copper.

The hull was caulked or sealed by caulkers, the highest paid of the ship building "mechanics". The planking seams were sealed with tarred hemp fibers, known as oakum. Joiners would smooth and plane the wood surface of the hull. Eventually the hull was sealed with a mixture of tree resin, sulfur, and tallow to repel boring teredo worms and barnacles. Once the hull was launched, it would swell in the saltwater thus helping to keep the new vessel somewhat watertight. During Bowditch's time, very wealthy shipowners covered the bottoms of their vessels in copper sheathing. Copper sheathing was very effective in protecting the hull from teredo worms and other destructive elements of the sea. Warships like the U.S.S. Constitution had copper sheathing to increase operational life. A well- built ship could be expected to last at least 20 to 30 years, if maintained properly.

BUILDING A WOODEN SHIP

1. What is the first step in building a wooden vessel?
2. What type of craftsmen began the first step of construction?
3. What kind of woods were the favored type to construct a ship?
4. Why were these woods favored?
5. What kind of wood were the masts and spars usually constructed of?
6. Why was the ship built at an angle?
7. The spine or backbone of the ship is called a _____.
8. The _____ acted like giant ribs providing a strong skeleton for the ship.
9. How did the carpenters fasten all the pieces of the ship together? Did they use iron and copper bolts and spikes?
10. Caulkers were the _____ paid of the mechanics that worked on ships.
11. What material did caulkers use to seal the seams between the wooded planks?
12. A mixture of _____was used to protect the ship from teredo worms and barnacles.
13. If a merchant could afford to, he could use _____ metal to cover the bottom of his ship to protect it from living organisms.
14. How many years could an average ship last?