SAN FRANCISCO MARITIME
NATIONAL PARK ASSOCIATION

Hyde Street Pier Science and Living History Programs

This document summarizes how the education programs offered by the San Francisco Maritime National Park Association address CA content-area standards.

The education programs at Hyde Street Pier provide a unique opportunity to bring the many strands of the content standards together in engaging, hands-on experiences. With the help of our crew of professional experiential education instructors, the students are persuaded to imagine the colorful world of the famous Barbary Coast waterfront in the mid-19th to early 20th century. As students are transported to the hard but adventurous life of a sailor, gold prospector, or merchant among the historic ships at San Francisco Maritime National Historic Park, they learn about the challenges posed by life in a different era. The programs integrate social studies, math, science, language arts, and visual and performing arts. Whether it's the physics of how a block-and-tackle works or the music and poetry of sea chanteys, the core themes of the content standards are presented in a lively and imaginative way.

Additional Classroom Activities

The educators on Hyde Street Pier work with teachers to make each group's experience the best it can be. This can include providing practice materials related to the AOS activities that can be used in-class to prepare for the students' eventual visit to the Pier. It can also include a possible early visit and instruction from an AOS educator. For suggested pre and post-visit lesson plans and activities, visit our website. The Hyde Street Pier education programs, in conjunction with in-class lessons and activities, form a complete system addressing CA content standards.

Age of Sail

It is 1906, just days after a devastating earthquake and fire destroyed most of San Francisco. Your students have been recruited to be the new crew of *Balclutha*, whose mission it is to sail to Oregon to bring lumber back to the ruined city so that rebuilding can begin.

During this program's 18-hour duration, your students spend the night on an authentic 19th century sailing ship and live the lives of sailors. The students are divided into groups. Each smaller crew has its own responsibility and job. All of these jobs were historically essential for the ship to function safely. Each individual crew member must learn to work together as a team, and all the crews must cooperate to run the ship. The students are guided by Age of Sail instructors, who play the roles of the ship's four officers. These roles are based on years of research on sailor archetypes from the period, so they are historically accurate, but they are also designed to fit the learning needs of the students.

The historical immersion aspect of this program is its most important characteristic. For one afternoon, evening, and morning, the students live the life of a sailor aboard a real merchant sailing ship. They participate in challenging tasks such as knot tying, swabbing decks, rigging and operating a bosun's chair, lowering and raising dories, and raising sail. The only way students can accomplish the tasks given to them is through communication and cooperation. They must use critical thinking, active listening, problem solving, teamwork, and leadership.

Meeting and Supporting the Standards
Grades 4 and 5: Age of Sail

The student activities in the Age of Sail (AOS) program are especially compatible with 4th and 5th grade California content standards for the STE fields (Earth Systems, Space Systems, and Engineering Design). In addition, students learn and apply skills called for in the Mathematics and English language arts standards.

- **Earth Systems/Plate Tectonics:** In 4th grade, students are expected to understand processes that shape the earth, especially in relation to plate tectonics and large-scale system interactions (ESS2.B).

- **Effects of Natural Hazards on Humans:** They must also "generate and compare solutions to reduce the impacts of natural Earth processes on humans" (4-ESS3-2). This is especially

important when discussing natural hazards such as earthquakes (ESS3.B). Such natural hazards are the result of natural processes. Students must understand that humans cannot eliminate these hazards, but can take steps to reduce their impacts.

The very setting of the AOS program – just a few days after the devastating 1906 San Francisco earthquake – is a lesson that supports students' understandings of concepts embedded in all of these standards. Since their mission as sailors on the *Balclutha* revolves around the devastation, the students learn first-hand the impact natural hazards such as earthquakes can have on human communities. They learn of the variety of steps taken to reduce the damage and fallout from this disaster, including prevention of future catastrophe. Further, as sailors onboard *Balclutha*, the students learn about the impact of dangerous weather systems on a ship at sea, including the steps sailors could take in order to increase the probability of survival during these storms.

In Class: Maps, Topography, Settlement Patterns

In the classroom, the content standards of the AOS program as outlined above can be further developed through additional lessons and discussion. Through use of maps describing Earth's features (4-ESS2-2), the 1906 San Francisco earthquake and storms at sea can be used as examples of how large-scale Earth system interactions occur in patterns (ESS2.B). When looking at maps of the earthquake specifically and the comparative destruction it had across the San Francisco Bay area, students can see clearly how different types of land were impacted in different ways. In the city, for example, the parts that were built on filled-in land were hit much harder by the earthquake itself than the parts that were built on natural land that was rocky and mountainous.

- **Space Systems:** In 5th grade, students must learn about space systems, especially how spatial bodies like the earth, sun, and moon interact with each other. This includes understanding that the gravitational force exerted by Earth on objects is directed down toward the planet's center (5-PS2-1, PS2.B). They must also understand that all objects in the solar system have similar gravitational pulls and therefore have impacts on each other. Specifically, the earth rotates around the sun, the moon rotates around the earth, and these rotations and gravitational interactions cause observable patterns (ESS1.B).

In the Age of Sail program the students learn to row a longboat in the aquatic park near Hyde Street Pier. For safety, this longboat is attached to the dock via a tether line, so the students row the longboat

out to the end of the tether and back. An important part of this activity is learning how the tides work. Students learn that the tides are created by the forces of the moon and the earth interacting with each other. These tides create currents in the Bay that can make the row more difficult or can make the row easer, depending on which direction the current is going at the time. In this way, the students not only learn about the gravitational forces exerted by the Earth and Moon, they also experience the strength of these forces and the patterns that they create by struggling to row against them.

In Class: Using Graphical Displays to Compare

In the classroom, these experiences can be enhanced through graphical displays (5-ESS1-2) and detailed discussion about the Sun's impact on the earth and its role as one star of countless in the universe. Its brightness and size in comparison with other stars are due to its close proximity to Earth (5-ESS1-1, ESS1.A).

- **Engineering:** Sailing ships like *Balclutha* were engineering masterpieces of their day, making Engineering Design one of the STEM fields that is most compatible with the AOS program. To meet 4th and 5th grade engineering standards, students must "define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost" (3-5-ETS1-1, ETS1.A). They must also work with peers at each stage of their design, because working together and sharing ideas "can lead to improved designs" (3-5-ETS1-2, ETS1.B). And finally, students must test aspects of their engineering model and determine how it can be improved (3-5-ETS1-3).

Throughout the AOS program, the students are given various tasks to accomplish together as a team. Each of these tasks has specific restraints on materials and time. The students must work together through multiple possible solutions to the problem given to them in order to accomplish their assigned tasks. From swabbing decks, to setting sails, to measuring the depth of the Bay using an old fashioned lead line, every activity the students do during the AOS program helps to meet the Engineering standards. The best example can be found with the bosun's chair activity. The bosun's chair is a pulley system used to raise sailors aloft with the purpose of making repairs to ship rigging. Students are tasked with constructing this system from base materials: chair, harness, lines, blocks, and belaying pins. As a team, students must identify the necessary materials themselves and then, step by step, use these materials to create the bosun chair system. At each step, the students must reach a specific solution using restricted timeframes and materials. Once the entire system is constructed, they must then learn

to use the system properly and raise people up in it. As with most activities on the pier, this activity fits especially well with "Crosscutting Concepts," as the students effectively learn the influence that science, engineering, and technology have had on society through hands-on problem solving experience.

Summary of 4th and 5th Grade Content Standards for Age of Sail

AOS 4th Grade Standards Directly Addressed

Standard	Standard Language
4-ESS3-2	Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.
ESS3.B	Natural Hazards: A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts.
ESS1.B	Earth and the Solar System: The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year.
3-5-ETS1-1	Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
ETS1.A	Defining and Delimiting Engineering Problems: Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.
ETS1.B	Developing Possible Solutions: At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs.
ETS1.C	Optimizing the Design Solution.
3-5-ETS1-2	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
3-5-ETS1-3	Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
4.OA	Operations and Algebraic Thinking **:** Use the four operations with whole numbers to solve problems.
4.OA.3	Solve multistep word problems posed with whole numbers and having whole-number answers using the four operations, including problems in which remainders must be interpreted. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding.
4.MD	Measurement and Data: Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit.

4.MD.2	Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale.
4.NBT	Number and Operation in Base Ten.
4.NF	Number and Operations – Fractions.
4.MD.5.a-b	Recognize angles as geometric shapes that are formed wherever two rays share a common endpoint, and understand concepts of angle measurement.
HSS4.4	Explaining how California became an agricultural and industrial power, tracing the transformation of the California economy and its political and cul-tural development.
SL4-8.1-6	Accomplishing objectives given through communication and cooperation, through critical thinking, active listening, problem solving, self-respect, teamwork, and leadership.
L4-8.1-6	Demonstrating command of the conventions of standard English grammar and usage when writing or speaking, using knowledge of language and its conventions when writing, speaking, reading, or listening, and determine or clarify the meaning of unknown and multiple-meaning words and phrases.
W4-8.2	Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.
W4-8.3	Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.
W4-8.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

AOS 4th Grade Standards Supported

Standard	Standard Language
4-ESS2-2	Analyze and interpret data from maps to describe patterns of Earth's features.
ESS2.B	Understanding processes that shape the earth, especially in relation to plate tectonics and large-scale system interactions.
4.G	Identifying lines and angles, and classify shapes by properties of their lines and angles.
4.MD	Solving problems involving measurement and conversion of measurements.
4.MD.5-7	Understanding concepts of angle and measure angles in geometric measurements.
4.G.1-3	Identifying lines and angles, and classify shapes by properties of their lines and angles.
RL4-8.1-10	Students gain adequate exposure to a range of texts and tasks. Students read increasingly complex texts through the grades.
RI4-8.1-10	Citing evidence, determining central text ideas and word meaning, analyzing how particular sections fit into overall text, tracing authors specific argument or point-of-view, and comparing

	and contrasting one author's presentation with that of another.
RF4-8.1-10	Develop students' understanding and working knowledge of concepts of print, the alphabetic principle, and other basic conventions of the English writing system.
W4-8.1-10	Students gain adequate mastery of a range of skills and applications. Each grade, students should demonstrate increasing sophistication in all aspects of language use, from vocabulary and syntax to the development and organization of ideas, and they should address increasingly demanding content and sources.

AOS 5th Grade Standards Directly Addressed

Standard	Standard Language
5-PS2-1	Understanding the gravitational forces of Earth acting on an object near Earth's surface pulls that object toward the planet's center.
PS2.B	Defining the gravitational forces exerted by objects in the solar system and how these forces impact each other.
ESS1.B	Earth and the Solar System: The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year.
3-5-ETS1-1	Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
ETS1.A	Defining and Delimiting Engineering Problems: Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.
ETS1.B	Developing Possible Solutions: At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs.
ETS1.C	Optimizing the Design Solution.
3-5-ETS1-2	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
3-5-ETS1-3	Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
5.NBT.5	Multiplying Number and Operation in Base Ten.
5.NF	Number and Operations – Fractions.
5.NF.6	Multiplying Fractions using Real-world problems.
HSS5.2	Tracing the routes of early explorers and describe the early explorations of the Americas.
HSS5.8	Tracing the colonization, immigration, and settlement patterns of the

	American people from 1789 to the mid-1800s, with emphasis on the role of economic incentives.
SL4-8.1-6	Accomplishing objectives given through communication and cooperation, through critical thinking, active listening, problem solving, self-respect, teamwork, and leadership.
L4-8.1-6	Demonstrating command of the conventions of standard English grammar and usage when writing or speaking, using knowledge of language and its conventions when writing, speaking, reading, or listening, and determine or clarify the meaning of unknown and multiple-meaning words and phrases.
W4-8.2	Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.
W4-8.3	Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.
W4-8.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

AOS 5th Grade Standards Supported

Standard	Standard Language
5-ESS1-2	Developing a model using an example to describe how different "spheres" of Earth interact.
5-ESS1-1	Supporting that differences in the apparent brightness of the sun compared to other stars is due to their relative distances from Earth.
ESS1.A	Define the Sun's impact on the earth and its role as one star of countless in the universe. Its brightness and size in comparison with other stars are due to its close proximity to Earth.
5.NBT.5	Multiplying Number and Operation in Base Ten.
5.NF	Number and Operations – Fractions.
5.NF.6	Multiplying Fractions using Real-world problems.
RL4-8.1-10	Students gain adequate exposure to a range of texts and tasks. Students read increasingly complex texts through the grades.
RI4-8.1-10	Citing evidence, determining central text ideas and word meaning, analyzing how particular sections fit into overall text, tracing authors specific argument or point-of-view, and comparing and contrasting one author's presentation with that of another.
RF4-8.1-10	Develop students' understanding and working knowledge of concepts of print, the alphabetic principle, and other basic conventions of the English writing system.
W4-8.1-10	Students gain adequate mastery of a range of skills and applications. Each grade, students should demonstrate increasing sophistication in all aspects of language use, from vocabulary and syntax to the development and organization of ideas, and they should address increasingly demanding content and sources.

Meeting and Supporting the Standards
Middle School (grades 6-8): Age of Sail

The student activities in the Age of Sail (AOS) program are especially compatible with middles school (6th - 8th grade) California content standards for the STE fields of Physical Science, Earth and Space Systems, and Engineering Design. In addition, students learn and apply skills called for in the Mathematics and English language arts standards.

- **Space and Earth Systems:** In order to prove competency in Space and Earth Systems, middle school students must understand models of the "Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons" (MS-ESS1-1).

- **The Role of Gravity:** Concurrently, they must understand "the role of gravity in the motions within galaxies and the solar system" (MS-ESS1-2, ESS1.B, ESS1.A). These patterns and forces of gravity, along with the energy of the sun, impact the cycling of water through Earth's systems (MS-ESS2-4).

In the AOS program the students learn to row a longboat in the aquatic park near Hyde Street Pier. For safety, this longboat is attached to the dock via a tether line, so the students row the longboat out to the end of the tether and back. An important part of this activity is learning how the tides work. Students learn that the tides are created by the forces of the moon and the earth interacting with each other. These tides create currents in the Bay that can make the row more difficult or can make the row easer, depending on which direction the current is going at the time. In this way, the students not only learn about the gravitational forces exerted by the earth and moon, they also experience the strength of these forces and the patterns that they create by struggling to row against them.

- **Weather and Climate:** Understanding tides and currents was essential to being a successful sailor. Indeed, it could mean the difference between life and death. Equally, if not more important, was having an understanding of weather and climate. In middle school, students must understand weather and climate through the development and use of models describing

the relationships between earth heating, rotation, atmospheric patterns, and oceanic circulation (MS-ESS2-6). These interactions are further influenced by living things and vary depending on latitude, altitude, and geography (ESS2.D). Students must also be able to discuss the evidence for the many "factors that have caused the rise in global temperatures over the past century" (MS- ESS3-5), especially human activity (ESS3.D, MS-ESS3-4).

In the AOS program, the students work on the ship as sailors whose livelihood depended on knowledge of weather and climate. They see and feel firsthand the "complex interactions of air masses" that affect weather conditions (MS-ESS2-5). They experience the powerful role that water, ocean temperatures, and currents have in determining local weather patterns (ESS2.C). Often, they see the changes for themselves as the fog roles through the Golden Gate, the rains come and go, or the winds change direction and strength.

- **Engineering:** Sailing ships like *Balclutha* were engineering masterpieces of their day, making Engineering Design one of the STEM fields that is most compatible with the AOS program. To meet middle school engineering standards, students must "define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution," while considering scientific principles and impacts that might limit possible design solutions (MS-ETS1-1, ETS1.A).

- **Problem Solving:** They must develop possible solutions (ETS1.B) by "using a systematic process to determine how well they meet the criteria and constraints of the problem" (MS-ETS1-2). Their solutions should then be optimized (ETS1.C) through tests and analysis of test data to identify the "best characteristics of each that can be combined into a new solution to better meet the criteria for success" (MS-ETS1-3). Finally, they must "develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved" (MS-ETS1-4).

Throughout the program, the students are given various tasks to accomplish together as a team. Each of these tasks has specific restraints on materials and time. The students must work and brainstorm together through multiple possible solutions to the problem given to them in order to accomplish their assigned tasks. From swabbing decks, to setting sails, to measuring the depth of the Bay using an old fashioned lead line, every activity the students do addresses these Engineering standards.

One of the best examples can be found with the bosun's chair activity. The bosun's chair is a pulley system used to raise sailors aloft with the purpose of making repairs to ship rigging. Students are tasked with constructing this system from base materials: chair, harness, lines, blocks, and belaying pins. As a team, students must identify the necessary materials themselves and then, step by step, use these materials to create the bosun chair system. At each step, the students must reach a specific solution using restricted timeframes and materials. Once the entire system is constructed, they must then learn to use the system properly and raise people up in it. As with most activities on the pier, this activity fits especially well with "Crosscutting Concepts," as the students effectively learn the influence that science, engineering, and technology have had on society through hands-on problem solving experience.

Summary of Middle School Content Standards for Age of Sail

AOS Middle School Standards Directly Addressed

Standard	Standard Language
MS-ESS1-1	Utilizing models of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.
MS-ESS1-2	Utilizing models of the larger celestial bodies to describe the role of gravity in the motions within galaxies and the solar system.
ESS1.B	Earth and the Solar System: The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year.
ESS1.A	Define the Sun's impact on the earth and its role as one star of countless in the universe. Its brightness and size in comparison with other stars are due to its close proximity to Earth.
MS-ESS2-4	Modeling patterns and forces of gravity, along with the energy of the sun, impact the cycling of water through Earth's systems.
MS-ETS1-1	Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
ETS1.A	Defining and Delimiting Engineering Problems: Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.
ETS1.B	Developing Possible Solutions: At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs.

MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
MS-ETS1-3	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
ETS1.C	Optimizing the Design Solution.
MS-ETS1-4	Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.
6.EE	Write and evaluate numerical expressions involving whole-number exponents.
6.EE.2	Write, read, and evaluate expressions in which letters stand for numbers.
6.EE.6	Using variables to represent numbers when solving real world problems.
6.EE.9	Using variables to represent two quantities in a real-world problem that change in relationship to one another.
7.NS	Applying and extending previous understandings of operations with fractions.
7.NS.3	Using understandings of operations with fractions for solving “real-world mathematical problems involving the four operations with rational numbers.
HSS7.11	Analyzing political and economic change in the sixteenth, seventeenth, and eighteenth centuries.
HSS8.8	Analyzing the divergent paths of the American people in the West from 1800 to the mid-1800s and the challenges they faced.
HSS8.12	Analyzing the transformation of the American economy and the chang-ing social and political conditions in the United States in response to the Indus-trial Revolution.
SL8.1-6	Accomplishing objectives given through communication and cooperation, through critical thinking, active listening, problem solving, self-respect, teamwork, and leadership.
SL4-8.1-6	Accomplishing objectives given through communication and cooperation, through critical thinking, active listening, problem solving, self-respect, teamwork, and leadership.
L4-8.1-6	Demonstrating command of the conventions of standard English grammar and usage when writing or speaking, using knowledge of language and its conventions when writing, speaking, reading, or listening, and determine or clarify the meaning of unknown and multiple-meaning words and phrases.
W4-8.2	Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.
W4-8.3	Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.
W4-8.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

AOS Middle School Standards Supported

Standard	Standard Language
MS-ESS2-5	Collecting data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.
ESS2.D	Developing a model determining how weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things.
ESS3.D	Applying scientific principles to design a method for monitoring and minimizing a human impact on the environment.
MS-ESS3-4	Constructing an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
MS-ESS3-5	Clarifying evidence of the factors that have caused the rise in global temperatures over the past century.
ESS2.C	Describing The Roles of Water in Earth's Surface Processes.
7.G	Drawing, constructing, and describing geometrical figures and describe the relationships between them.
7.G.2	Drawing Geometric shapes with given conditions.
7.G.5	Using facts about supplementary, complementary, vertical, and adjacent angles in a multi-step problems.
RL4-8.1-10	Students gain adequate exposure to a range of texts and tasks. Students read increasingly complex texts through the grades.
RI4-8.1-10	Citing evidence, determining central text ideas and word meaning, analyzing how particular sections fit into overall text, tracing authors specific argument or point-of-view, and comparing and contrasting one author's presentation with that of another.
RF4-8.1-10	Develop students' understanding and working knowledge of concepts of print, the alphabetic principle, and other basic conventions of the English writing system.
W4-8.1-10	Students gain adequate mastery of a range of skills and applications. Each grade, students should demonstrate increasing sophistication in all aspects of language use, from vocabulary and syntax to the development and organization of ideas, and they should address increasingly demanding content and sources.

Life on the Barbary Coast Day Program (LIFE)

Just like the Age of Sail Overnight, this shortened, four-hour program puts your students in 1906 as the new crew of *Balclutha*. They have volunteered to help the captain prepare for the evening cast-off and must learn to run the ship as sailors from the period. Performing many of the same activities as the overnight, students are encouraged to develop teamwork and active listening skills to tackle the challenges of life at sea, all under the watchful eyes of the ship's "officers." Since students on the LIFE program experience many of the same activities as the Age of Sail program above, many of the above descriptions fit this program as well, so the LIFE program accomplishes many of the same standards with some exceptions due to this program's shorter duration.

Summary of 4th through 8th Grade Content Standards for LIFE

Standards Directly Addressed

Standard	Standard Language
4-ESS3-2	Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.
ESS3.B	Natural Hazards: A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts.
5-PS2-1	Understanding the gravitational forces of Earth acting on an object near Earth's surface pulls that object toward the planet's center.
PS2.B	Defining the gravitational forces exerted by objects in the solar system and how these forces impact each other.
ESS1.B	Earth and the Solar System: The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year.
3-5-ETS1-1	Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
ETS1.A	Defining and Delimiting Engineering Problems: Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.
ETS1.B	Developing Possible Solutions: At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved

	designs.
ETS1.C	Optimizing the Design Solution.
3-5-ETS1-2	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
3-5-ETS1-3	Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
MS-ESS1-1	Utilizing models of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.
MS-ESS1-2	Utilizing models of the larger celestial bodies to describe the role of gravity in the motions within galaxies and the solar system.
ESS1.B	Earth and the Solar System: The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year.
ESS1.A	Define the Sun's impact on the earth and its role as one star of countless in the universe. Its brightness and size in comparison with other stars are due to its close proximity to Earth.
MS-ESS2-4	Modeling patterns and forces of gravity, along with the energy of the sun, impact the cycling of water through Earth's systems.
MS-ETS1-1	Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
ETS1.A	Defining and Delimiting Engineering Problems: Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.
ETS1.B	Developing Possible Solutions: At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs.
MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
MS-ETS1-3	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
ETS1.C	Optimizing the Design Solution.
MS-ETS1-4	Develop a model to generate data for iterative testing and modification of a proposed object,

	tool, or process such that an optimal design can be achieved.
4.OA	Operations and Algebraic Thinking **:** Use the four operations with whole numbers to solve problems.
4.OA.3	Solve multistep word problems posed with whole numbers and having whole-number answers using the four operations, including problems in which remainders must be interpreted. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding.
4.MD	Measurement and Data: Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit.
4.MD.2	Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale.
4.NBT	Number and Operation in Base Ten.
4.NF	Number and Operations – Fractions.
4.MD.5.a-b	Recognize angles as geometric shapes that are formed wherever two rays share a common endpoint, and understand concepts of angle measurement.
5.NBT.5	Multiplying Number and Operation in Base Ten.
5.NF	Number and Operations – Fractions.
5.NF.6	Multiplying Fractions using Real-world problems.
6.EE	Write and evaluate numerical expressions involving whole-number exponents.
6.EE.2	Write, read, and evaluate expressions in which letters stand for numbers.
6.EE.6	Using variables to represent numbers when solving real world problems.
6.EE.9	Using variables to represent two quantities in a real-world problem that change in relationship to one another.
7.NS	Applying and extending previous understandings of operations with fractions.
7.NS.3	Using understandings of operations with fractions for solving “real-world mathematical problems involving the four operations with rational numbers.
HSS4.4	Explaining how California became an agricultural and industrial power, tracing the transformation of the California economy and its political and cul-tural development.
HSS5.2	Tracing the routes of early explorers and describe the early explorations of the Americas.
HSS5.8	Tracing the colonization, immigration, and settlement patterns of the American people from 1789 to the mid-1800s, with emphasis on the role of economic incentives.

HSS7.11	Analyzing political and economic change in the sixteenth, seventeenth, and eighteenth centuries.
HSS8.8	Analyzing the divergent paths of the American people in the West from 1800 to the mid-1800s and the challenges they faced.
HSS8.12	Analyzing the transformation of the American economy and the chang-ing social and political conditions in the United States in response to the Indus-trial Revolution.
SL4-8.1-6	Accomplishing objectives given through communication and cooperation, through critical thinking, active listening, problem solving, self-respect, teamwork, and leadership.
L4-8.1-6	Demonstrating command of the conventions of standard English grammar and usage when writing or speaking, using knowledge of language and its conventions when writing, speaking, reading, or listening, and determine or clarify the meaning of unknown and multiple-meaning words and phrases.

Standards Supported

Standard	**Standard Language**
4-ESS2-2	Analyze and interpret data from maps to describe patterns of Earth's features.
ESS2.B	Understanding processes that shape the earth, especially in relation to plate tectonics and large-scale system interactions.
5-ESS1-2	Developing a model using an example to describe how different "spheres" of Earth interact.
5-ESS1-1	Supporting that differences in the apparent brightness of the sun compared to other stars is due to their relative distances from Earth.
ESS1.A	Define the Sun's impact on the earth and its role as one star of countless in the universe. Its brightness and size in comparison with other stars are due to its close proximity to Earth.
MS-ESS2-5	Collecting data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.
ESS2.D	Developing a model determining how weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things.
ESS3.D	Applying scientific principles to design a method for monitoring and minimizing a human impact on the environment.
MS-ESS3-4	Constructing an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
MS-ESS3-5	Clarifying evidence of the factors that have caused the rise in global temperatures over the

	past century.
ESS2.C	Describing The Roles of Water in Earth's Surface Processes.
4.G	Identifying lines and angles, and classify shapes by properties of their lines and angles.
4.MD	Measurement and Data: Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit.
4.MD.5-7	Understanding concepts of angle and measure angles in geometric measurements.
4.G.1-3	Identifying lines and angles, and classify shapes by properties of their lines and angles.
5.NBT.5	Multiplying Number and Operation in Base Ten.
5.NF	Number and Operations – Fractions.
5.NF.6	Multiplying Fractions using Real-world problems.
7.G	Drawing, constructing, and describing geometrical figures and describe the relationships between them.
7.G.2	Drawing Geometric shapes with given conditions.
7.G.5	Using facts about supplementary, complementary, vertical, and adjacent angles in a multi-step problems.
RL4-8.1-10	Students gain adequate exposure to a range of texts and tasks. Students read increasingly complex texts through the grades.
RI4-8.1-10	Citing evidence, determining central text ideas and word meaning, analyzing how particular sections fit into overall text, tracing authors specific argument or point-of-view, and comparing and contrasting one author's presentation with that of another.
RF4-8.1-10	Develop students' understanding and working knowledge of concepts of print, the alphabetic principle, and other basic conventions of the English writing system.
W4-8.1-10	Students gain adequate mastery of a range of skills and applications. Each grade, students should demonstrate increasing sophistication in all aspects of language use, from vocabulary and syntax to the development and organization of ideas, and they should address increasingly demanding content and sources.

Explorers STEM Sailing Program on *Alma*

Take your class on a voyage into history aboard the *Alma*! Built in 1891, the *Alma* is one of the last surviving links to San Francisco's maritime past, is Coast Guard licensed and inspected to carry passengers, and operated by a professional skipper and crew. You will sail the beautiful waters of San Francisco Bay with the exhilaration of the wind at your back, the sun on your face, and the deck of a historic sailing schooner under your feet. With our instructors, students work in small groups and learn to navigate using a magnetic compass, charts, and speed equations. They will also learn the science behind wind, weather, and how they impact the environment of the bay and are used to power the sails. Interspersed with these lessons are chances to actually sail the *Alma* themselves by hoisting the sails and even taking a trick at the helm with *Alma*'s captain. Through these activities and experiences, the students learn first-hand what it was like for early explorers and immigrants to travel to the bay by sea.

Meeting and Supporting the Standards
Grades 4 and 5: Explorers

Science, Technology, and Engineering

The student activities in the Explorers educational program are especially compatible with 4th and 5th grade California content standards for the STE fields of Earth Systems and Space Systems.

- **4th Grade Earth Systems:** In 4th grade, students are expected to understand processes that shape the earth, especially in relation to plate tectonics and large-scale system interactions (ESS2.B). They must also "generate and compare solutions to reduce the impacts of natural Earth processes on humans" (4-ESS3-2). This is especially important when discussing natural hazards such as earthquakes (ESS3.B). Such natural hazards are the result of natural processes. Students must understand that humans cannot eliminate these hazards but can take steps to reduce their impacts.

During the history station on Alma students learn about the history of the San Francisco Bay while sailing through it. This includes analysis of maps of the Bay Area as it developed over time (4-ESS2-2). This analysis and discussion includes changes to topography, especially settlement in mountainous areas and expansion of land and settlement in areas that were once water. This analysis also includes discussion of

what happens when natural disasters, such as earthquakes, hit the area and their varying impact depending on where people had settled.

- **5th Grade Earth Systems:** These discussions also relate to 5th grade Earth System standards. Analysis of historic maps from the first Spanish maps of the Bay Area to modern twentieth century maps demonstrates the huge impact human settlement in the area has had on the water of the bay (5-ESS2-2). As more people settle the area, the bay shrinks. Much of the city of San Francisco itself, as one example, has been built over "reclaimed'' land (ESS2.C). This demonstration then leads to discussion of the impacts such human actions has on local environment, ecosystems, and general earth systems (ESS2.C, 5-ESS3-1).

- **Space Systems:** In 5th grade, students must learn about space systems, especially how spatial bodies like the Earth, Sun, and Moon interact with each other. This includes understanding that the gravitational force exerted by Earth on objects is directed down toward the planet's center (5-PS2-1, PS2.B). They must also understand that all objects in the solar system have similar gravitational pulls and therefore have impacts on each other. Specifically, the earth rotates around the sun, the moon rotates around the earth, and these rotations and gravitational interactions cause observable patterns (ESS1.B).

During the Explorers program's science station, the students learn how the tides work. Through discussion and models (5-ESS1-2) they learn that they are created by the forces of the moon and the earth interacting with each other. These tides create powerful currents in the Bay, knowledge of which was essential for the success and survival of *Alma*'s sailors.

During the science activities, students also learn about earth systems and how they interact to create the wind necessary to propel the boat they are sailing on. Hot air over the inland areas rises creating a vacuum which pulls ocean air in from over the Pacific and blows over the bay as wind. Students engage with these concepts through visual aids and hands-on demonstration (5-ESS2-1, ESS2.C).

Mathematics

The following is based on the California Common Core State Standards (https://www.cde.ca.gov/be/st/ss/documents/ccssmathstandardaug2013.pdf). These standards list eight base mathematical practices that are encouraged in common core:

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.

The Explorers program supports each of these practices through direct, real world problem solving experience. As the students sail aboard the historic scow-schooner *Alma*, the students rotate through four different stations: science, navigation, history, and helm. Every station has activities that require the students to work together strategically. They must reason out problems as a team and persevere through complications, mistake, and missteps. Many of the steps of these activities require direct application of mathematical models and tools, including Algebra (4.OA), Number and Operations (4.NBT, 4.NF), Measurement and Data (4.MD), and Geometry (4.G).

4th Grade

- **Word Problems with Measurements:** In the 4th grade, students must solve multistep word problems using the four operations and whole numbers (4.OA, 4.OA.3). These word problems must involve "measurement and conversion of measurements from a larger unit to a smaller unit" (4.MD) including distances and intervals of times (4.MD.2). They must competently represent and interpret measurement data including the use of fractions when necessary (4.MD.4, 4.NBT, 4.NF).

While sailing on *Alma*, the students go to a science station where they learn all about the natural sciences of the San Francisco Bay while they sail through it. This includes, especially, lessons and activities involving the need of wind to propel a sailing boat like the *Alma*, and where and why this wind occurs on the bay. Students also become sailors themselves and learn the science and mathematics

behind how sailors from *Alma*'s time determined their speed. This includes numerous examples and mathematical equations that the students learn and work through in order to understand the process. For example, prior to the 1500s, sailors would note how long it took a piece of debris to float past their boat or ship. Alma is 80 feet long, so if it takes debris 4 seconds to pass the whole boat, then you are moving 80 feet every 4 seconds, or 20ft/sec. This would then need to be converted into nautical miles, or "knots." This entire conversion process is represented by the equation:

Speed (knots) = Distance (nautical miles)/Time (hours)

Or: S=D/T

After working through how and why the calculations work, the students then put their knowledge into practice. They work together to measure how fast the *Alma* is currently going by using a "chip log," which was a more precise system invented after the 1500s and used during *Alma*'s time. Put simply, a wooden chip attached to a spooled line is thrown into the water and it is timed how long it takes for the spool to run out. If the Alma were going just 1 knot, then it would take exactly 60 seconds for the spool to run out. The students throw the chip into the water, measure the distance and time, and then calculate how fast the *Alma* is going. They do this multiple times in order to be sure there is an accurate proper reading.

- **Angles and Shapes:** 4th grade students must also "recognize angles as geometric shapes that are formed wherever two rays share a common endpoint, and understand concepts of angle measurement" (4.MD.5). They must be able to "sketch angles of specified measure" and measure such angles using mathematical tools like a protractor (4.MD.6). These are best represented by real-world problems and mathematical diagrams where the students can find unknown angles using addition and subtraction (4.MD.7). Students must then be able to identify shapes based on their lines and angles (4.G.1-3).

During the Explorers program the students learn how to navigate as sailors from *Alma*'s time would have navigated. For this activity, the students use a number of tools, including a nautical chart, bearing compass, and parallel rule. They use LOPs (Lines of Positions) based on landmarks, each ideally 120 degrees apart. These lines, their crossing, the angles, and the shapes they make are how they determine their position on the nautical chart. The students work together to obtain their positioning and take multiple bearings from different landmarks and as the boat travels to compare the differences.

5th Grade

- **Word Problems with Multiplication and Division:** In 5th grade, students must "apply and extend understandings of multiplication and division to multiply and divide fractions" (5.NF). As always, these are best represented with real-world problems "by using visual fraction models or equations to represent the problem" (5.NF.6). They must also be able to divide unit fractions by whole numbers and vise versa (5.NF.7, 5.NF.7.C).

While sailing on *Alma*, the students go to a science station where they learn all about the natural sciences of the San Francisco Bay while they sail through it. This includes, especially, lessons and activities involving the need of wind to propel a sailing boat like the *Alma*, and who and why this wind occurs on the Bay. Students also become sailors themselves and learn the science and mathematics behind how sailors from *Alma*'s time determined their speed. This includes numerous examples and mathematical equations that they students learn and work through in order to understand the process. For example, prior to the 1500s, sailors would note how long it took a piece of debris to float past their boat or ship. Alma is 80 feet long, so if it takes debris 4 seconds to pass the whole boat, then you are moving 80 feet every 4 seconds, or 20ft/sec. This would then need to be converted into nautical miles, or "knots." This entire conversion process is represented by the equation:

Speed (knots) = Distance (nautical miles)/Time (hours)

Or: S=D/T

After working through how and why the calculations work, the students then put their knowledge into practice. They work together to measure how fast the *Alma* is currently going by using a "chip log," which was a more precise system invented after the 1500s and used during *Alma*'s time. Put simply, a wooden chip attached to a spooled line is thrown into the water and it is timed how long it takes for the spool to run out. If the Alma were going just 1 knot, then it would take exactly 60 seconds for the spool to run out. The students throw the chip into the water, then measure the distance, time, and calculate how fast the *Alma* is going. They do this multiple times, in order to be sure there is a proper reading.

- **Geometry:** 5th grade geometry revolves around the students learning "points on the coordinate plane to solve real-world and mathematical problems." Students must learn about "perpendicular number lines," or axis (5.G.1) and be able to graph points in order to solve real-world problems (5.G.2).

Understanding angles, lines, and being able to represent them in these ways were essential to a life at sea on sailing boats like *Alma*. For the Explorers navigation activity, the students learn why as they learn how to navigate as sailors from *Alma*'s time would have navigated. For this activity, the students use a number of tools, including a nautical chart, bearing compass, and parallel rule. They use LOPs (Lines of Positions) based on landmarks, each ideally 120 degrees apart. These lines, their crossing, the angles, and the shapes they make are how they determine their position on the nautical chart. The students work together to obtain their positioning and take multiple bearings from different landmarks and as the boat travels to compare the differences.

Summary of 4th and 5th Grade Content Standards for Explorers

Standards Directly Addressed

Standard	Standard Language
4.OA	Operations and Algebraic Thinking **:** Use the four operations with whole numbers to solve problems.
4.OA.3	Solve multistep word problems posed with whole numbers and having whole-number answers using the four operations, including problems in which remainders must be interpreted. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding.
4.MD	Measurement and Data: Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit.
4.MD.2	Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale.
4.MD.4	Representing and interpreting measurement data including the use of fractions when necessary.
4.NBT	Numbers and Operations in Base Ten.
4-5.NF	Numbers and Operations including fractions.
4.MD.5	Recognize angles as geometric shapes that are formed wherever two rays share a common endpoint, and understand concepts of angle measurement.
4.MD.7	Using real world problems and mathematical diagrams to find unknown angles using additions and subtraction.

4.G.1-3	Identifying lines and angles, and classify shapes by properties of their lines and angles.
5.NF.6	Solve real-world problems involving multiplication of fractions and mixed numbers.
5.NF.7	Apply and extend previous understandings of division to divide unit fractions by whole numbers and whole numbers by unit fractions.
5.NF.7.C	Solve real-world problems involving division of unit fractions by non-zero whole numbers and division of whole numbers by unit fractions, e.g., by using visual fraction models and equations to represent the problem.
5.G.1-2	Graph points on the coordinate plane to solve real-world and mathematical problems.
5-ESS2-1	Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
5-PS2-1	Understanding the gravitational forces of Earth acting on an object near Earth's surface pulls that object toward the planet's center.
5-ESS1-2	Developing a model using an example to describe how different "spheres" of Earth interact.
4-ESS2-2	Analyze and interpret data from maps to describe patterns of Earth's features.
5-ESS2-2	Analysis of historic maps and modern twentieth century maps to demonstrates the huge impact human settlement in the area has had on the water of the Bay Area.
HSS4.1	Demonstrate an understanding of the physical and human geographic features that define places and regions in California.
HSS4.2	Describe the social, political, cultural, and economic life and interactions among people of California.
HSS4.3	Explain the economic, social, and political life in Californian History
HSS5.1	Describe the major pre-Columbian settlements, including the cliff dwellers and pueblo people of the desert Southwest, the American Indians of the Pacific Northwest, the nomadic nations of the Great Plains, and the wood-land peoples east of the Mississippi River.
HSS5.2	Tracing the routes of early explorers and describe the early explorations of the Americas.
HSS5.8	Tracing the colonization, immigration, and settlement patterns of the American people from 1789 to the mid-1800s, with emphasis on the role of economic incentives.
SL4-8.1-6	Accomplishing objectives given through communication and cooperation, through critical thinking, active listening, problem solving, self-respect, teamwork, and leadership.
L4-8.1-6	Demonstrating command of the conventions of standard English grammar and usage when writing or speaking, using knowledge of language and its conventions when writing, speaking, reading, or listening, and determine or clarify the meaning of unknown and multiple-meaning words and phrases.

Standards Supported

Standard	Standard Language
RL4-8.1-10	Students gain adequate exposure to a range of texts and tasks. Students read increasingly complex texts through the grades.
RI4-8.1-10	Citing evidence, determining central text ideas and word meaning, analyzing how particular sections fit into overall text, tracing authors specific argument or point-of-view, and comparing and contrasting one author's presentation with that of another.
RF4-8.1-10	Develop students' understanding and working knowledge of concepts of print, the alphabetic principle, and other basic conventions of the English writing system.
W4-8.1-10	Students gain adequate mastery of a range of skills and applications. Each grade, students should demonstrate increasing sophistication in all aspects of language use, from vocabulary and syntax to the development and organization of ideas, and they should address increasingly demanding content and sources.

Meeting and Supporting the Standards
Middle School (grades 6-8): Explorers

The student activities of the Explorers educational program are compatible especially with middles school (6th - 8th grade) California content standards for the STE fields of Physical Science, Earth, and Space Systems.

- **Space Systems:** In middle school, students must demonstrate understanding of forces and interactions through the construction and presentation of "arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects (MS-PS2-4). This includes developing models of the "Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons (MS-ESS1-1, MS-ESS1-2, ESS1.B, ESS1.A).

During the Explorers program's science station, the students learn how the tides work. Through discussion and models they learn how tides are created by the forces of the moon, the Earth, and sun interacting with each other (MS-ESS2-4). These tides create powerful currents in the bay, knowledge of which was essential for the success and survival of *Alma* sailors.

- **Weather and Climate:** Students in middle school are also expected to learn about weather and climate. They must "collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions" (MS-ESS2-5, ESS2.C) and "develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates" (MS-ESS2-6, ESS2.D).

Also during the science activities students learn about earth systems and how they interact to create the wind necessary to propel the boat they are sailing on. Hot air over the inland areas rises creating a vacuum which pulls ocean air in from over the Pacific and blows over the bay as wind. Students engage with these concepts through visual aids, maps, satellite images and hands-on demonstration.

- **Climate Change:** And finally, students are expected to discuss global climate change, especially the many "factors that have cause the rise in global temperatures over the past century" (MS-ESS3-5) including human activities (ESS3.D, MS-ESS3-4).

During the history station on *Alma* students learn about the history of the San Francisco Bay while sailing through it. This includes analysis of maps of the Bay Area as it developed over time. This analysis and discussion includes changes to topography, especially settlement in mountainous areas and expansion of land and settlement in areas that were once water. This analysis includes discussion of what happens when natural disasters, such as earthquakes, hit the area and their varying impact depending on where people had settled. These activities strongly support in-class discussions of these very important topics.

Mathematics

The following is based on the California Common Core State Standards (https://www.cde.ca.gov/be/st/ss/documents/ccssmathstandardaug2013.pdf). These standards list eight base mathematical practices that are encouraged in common core:

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.

The Explorers program supports each of these practices through direct, real world problem solving experience. As the students sail aboard the historic scow-schooner *Alma*, the students rotate through four different stations: science, navigation, history, and helm. Every station has activities that require the students to work together strategically. They must reason out problems as a team and persevere through complications, mistake, and missteps.

- **In 6th grade**, students must learn to "write, read, and evaluate expressions in which letters stand for numbers" (6.EE, 6.EE.2). These expressions should be used to solve real-world problems (6.EE.6) and "quantitative relationships between dependent and independent variables" (6.EE.9).
- **In 7th grade**, students must "apply and extend previous understandings of operations with fractions" (7.NS) by solving "real-world mathematical problems involving the four operations with rational numbers" (7.NS.3).

While sailing on Alma, the students go to a science station where they learn all about the natural sciences of the San Francisco Bay while they sail through it. This includes, especially, lessons and activities involving the need of wind to propel a sailing boat like the Alma, and where and why this wind occurs on the Bay. Students also become sailors themselves and learn the science and mathematics behind how sailors from Alma's time determined their speed. This includes numerous examples and mathematical equations that they students learn and work through in order to understand the process. For example, prior to the 1500s, sailors would note how long it took a piece of debris to float past their boat or ship. Alma is 80 feet long, so if it takes debris 4 seconds to pass the whole boat, then you are moving 80 feet every 4 seconds, or 20ft/sec. This would then need to be converted into nautical miles, or "knots." This entire conversion process is represented by the equation:

Speed (knots) = Distance (nautical miles)/Time (hours)

Or: S=D/T

After working through how and why the calculations work, the students then put their knowledge into practice. They work together to measure how fast the Alma is currently going by using a "chip log,"

which was a more precise system invented after the 1500s and used during Alma's time. Put simply, a wooden chip attached to a spooled line is thrown into the water and it is timed how long it takes for the spool to run out. If the Alma were going just 1 knot, then it would take exactly 60 seconds for the spool to run out. The students throw the chip into the water, measure the distance and time, and then calculate how fast the Alma is going. They do this multiple times, in order to be sure there is an accurate reading.

- **7th grade geometry** revolves around drawing (freehand, with ruler and protractor, and with technology), constructing, and describing relationships between them. Students should "focus on constructing triangles from three measures of angles or sides, noticing when the conditions determine a unique triangle, more than one triangle, or no triangle" (7.G.2, 7.G.5).

For the Explorers navigation activity, the students learn why as they learn how to navigate as sailors from Alma's time would have navigated. For this activity, the students use a number of tools, including a nautical chart, bearing compass, and parallel rule. They use LOPs (Lines of Positions) based on landmarks, each ideally 120 degrees apart. These lines, their crossing, the angles, and the shapes they make are how they determine their position on the nautical chart. The students work together to obtain their positioning and take multiple bearings from different landmarks and as the boat travels to compare the differences.

Summary of Middle School (6th-8th) Content Standards for Explorers

Standards Directly Addressed

MS-PS2-4	Demonstrate understanding of forces and interactions through the construction and presentation of "arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.
MS-ESS1-1	Utilizing models of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.
MS-ESS1-2	Utilizing models of the larger celestial bodies to describe the role of gravity in the motions within galaxies and the solar system.
MS-ESS2-4	Modeling patterns and forces of gravity, along with the energy of the sun, impact the cycling of water through Earth's systems.

MS-ESS2-5	Collecting data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.
MS-ESS2-6	Understand weather and climate through the development and use of models describing the relationships between the Earth heating, rotation, atmospheric patterns, and oceanic circulation.
HSS7.11	Analyzing political and economic change in the sixteenth, seventeenth, and eighteenth centuries.
HSS8.5	Analyze US Foreign Policy in the early Republic.
HSS8.8	Analyzing the divergent paths of the American people in the West from 1800 to the mid-1800s and the challenges they faced.
SL4-8.1-6	Accomplishing objectives given through communication and cooperation, through critical thinking, active listening, problem solving, self-respect, teamwork, and leadership.
L4-8.1-6	Demonstrating command of the conventions of standard English grammar and usage when writing or speaking, using knowledge of language and its conventions when writing, speaking, reading, or listening, and determine or clarify the meaning of unknown and multiple-meaning words and phrases.

Standards Supported

Standard	Standard Language
4-ESS2-2	Analyze and interpret data from maps to describe patterns of Earth's features.
5-ESS3-1	Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
5-LS2-1	Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
4-ESS3-2	Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.
RL4-8.1-10	Students gain adequate exposure to a range of texts and tasks. Students read increasingly complex texts through the grades.
RI4-8.1-10	Citing evidence, determining central text ideas and word meaning, analyzing how particular sections fit into overall text, tracing authors specific argument or point-of-view, and comparing and contrasting one author's presentation with that of another.
RF4-8.1-10	Develop students' understanding and working knowledge of concepts of print, the alphabetic principle, and other basic conventions of the English writing system.
W4-8.1-10	Students gain adequate mastery of a range of skills and applications. Each grade, students should demonstrate increasing sophistication in all aspects of language use, from vocabulary and syntax to the development and organization of ideas, and they should address increasingly demanding content and sources.

Gold Rush Day Program

For this four-hour living history program your students are transported back to 1849 San Francisco. Since the discovery of gold in Coloma just a year before, tens of thousands of people from all over the world have flooded the area and the city is booming with opportunity. The students are brought aboard the historic sailing ship *Balclutha* where they meet the gold-crazed miner, the stern ship captain, and the business-savvy merchant. Played by experienced Age of Sail instructors, each of these characters will guide the students through fun hand-son learning activities while regaling them with stories of their lives and history. After meeting each character, the students then get a chance to choose which of these three opportunities is best for them.

The Gold Rush program teaches students about one of the most important periods in the history of California through direct, fully-immersive experience. They also learn about the periods before and after the Gold Rush, including its important impacts on the state's development, through discussion and demonstration. The Gold Rush activities teach students more than history, as they are often challenged to think critically and mathematically in order to complete certain tasks. Further, this program supports in-class discussion of many earth science standards, as students learn of the importance of such knowledge for the successful mining of gold. Once the students choose their preferred Gold Rush profession, they learn what became of themselves and discuss these outcomes, and their historical implications, with the ship's captain.

What will be your students' fates on this living history adventure?

Meeting and Supporting the Standards
Grade 4: Gold

History and Social Science

K – 5th Historical Analysis Skills

Among other skills, K-5 students are expected to demonstrate Chronological and Spatial Thinking by placing "key events and people of the historical era they are studying in a chronological sequence and within a spatial context," explaining "how the present is connected to the past, identifying both similarities and differences between the two, and how some things change over time and some things stay the same," and judging "the significance of the relative location of a place (e.g., proximity to a harbor, on trade routes) and analyze how relative advantages or disadvantages can change over time." Historical Interpretation skills focus on students being able to "summarize key events" and "explain historical context of those events." Students must also "identify the human and physical characteristics of the places they are studying and explain how those features form the unique character of those places."

Through experiential learning, the Gold Rush program achieves a level of historical chronological and spacial awareness that is not possible with classroom instruction alone. By living for a day in the time they are studying, students gain historical empathy, which is key to understanding the past. They know the differences and similarities between past and present through first-hand experience and they know the significance of location in history because they have lived for a day on a real historic sailing ship docked at one of the most historic and significant harbors in the world.

The Research, Evidence, and Point of View skills that K-5 students are expected to demonstrate are related to understanding the difference between various types of historical sources and observations. This includes being able to differentiate between primary and secondary sources, being able to "pose relevant questions about events they encounter" in various types of historical documents and sources, and being able to "distinguish fact from fiction by comparing documentary sources on historical figures and events with fictionalized characters and events."

During the Gold Rush Program students work through experiential learning activities on a floating primary source: the sailing ship *Balclutha*. The students also learn the stories of those that lived during the Gold Rush through direct experience and through in-depth discussion and reflection with the ship's captain, the Gold Rush instructor who leads the contemplative debrief at the end of every program. The students also meet a gold miner and merchant. Each of these characters, the Captain, gold miner, and merchant, are based on historical archetypes for these professions from the period and have evolved through years of program development and historical research. Discussion of their experiences in the classroom preceding and following their day on the pier can further enrich their understanding and practice of these historical skills.

Specific History Topics and Standards

In 4th grade students learn about the history of California from pre-Columbian societies to around 1900. The Gold Rush program has evolved over years to correspond directly to these 4th grade historical topics and standards. Through experiential learning on location, students receive a level of "understanding of the physical and human geographic features that define places and regions in California" that is not possible in the usual classroom setting **(4.1).** Students also gain a detailed understanding of the Gold Rush and what it meant for San Francisco and California **(4.3)**. They do this by visiting the waterfront where the history actually occurred, working on a real nineteenth century sailing ship, and meeting characters from the period. There were many opportunities for people coming to the area looking for success. The students experience each through active learning and then choose which

they feel works best for them. They then learn their fate, whether they were successful or not. Each of these fates are based on many of the actual fates the thousands of people arriving in San Francisco might have experienced. They then discuss their fates with the ship captain during a program debrief, where they also hypothesize and discuss the future of San Francisco and the State of California, including its agricultural and industrial power **(4.4)**.

Mathematics

The following is based on the California Common Core State Standards (https://www.cde.ca.gov/be/st/ss/documents/ccssmathstandardaug2013.pdf). These standards list eight base mathematical practices that are encouraged in common core:

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.

The Gold Rush program supports each of these practices through direct, real world problem solving experience. The students go through three activity rotations, each representing a possible occupation from the Gold Rush period. As will be outlined below, the learning activities of the merchant rotation are the most directly associated with 4th and 5th grade core standards for mathematics. At the end of the program, students must use the information presented to them from each rotation to decide which profession would be best for them. As a group, they discuss the results of these decisions by making sense of the outcomes, overcoming presented problems, and critiquing each other's reasoning.

4th Grade

- **Multistep Word Problems:** In the 4th grade, students must solve multistep word problems using the four operations and whole numbers (4.OA, 4.OA.3). These word problems must involve "measurement and conversion of measurements from a larger unit to a smaller unit"

(4.MD) including monetary units (4.MD.2). Students must also work with numbers in base ten (4.NBT) and gain basic understanding of fractions (4.NF).

During the Gold Rush program, the students go through three activity rotations, each representing a possible occupation from the Gold Rush period. Though each activity rotation demands basic reasoning based on the common core mathematical practices outlined above, it is the activities of the merchant rotation that are the most directly associated with 4th grade core standards for mathematics. Here, the students learn the skills needed to be a successful business person from the period. The focus especially is on the concepts of supply and demand. The students act out what they learn in a real world setting. A few students act as shop keepers, while the rest act as miners looking to buy their supplies. The merchant character, played by a Hyde Street outdoor educator, acts as the investor, loaning money to both the shopkeepers and the miners. All of the students must negotiate sales while considering multiple mathematical models. They must try and sell all of their wares to make a profit, or use what little money they have to purchase all the gear they need, while also considering the money they will owe their investor, the merchant, which always includes a certain amount of interest added to the loan.

5th Grade

- **Decimals:** In 5th grade, students must add, subtract, multiply, and divide decimals to hundredths (5.NBT, 5.NBT.7) and multiply fractions using real-world problems (5.NF.6).

During the Gold Rush program, the students go through three activity rotations, each representing a possible occupation from the Gold Rush period. Though each activity rotation demands basic reasoning based on the common core mathematical practices outlined above, it is the activities of the merchant rotation that are the most directly associated with 4th grade core standards for mathematics. Here, the students learn the skills needed to be a successful business person from the period. The focus especially is on the concepts of supply and demand. The students act out what they learn in a real world setting. A few students act as shop keepers, while the rest act as miners looking to buy their supplies. The merchant character, played by a Hyde Street outdoor educator, acts as the investor, loaning money to both the shopkeepers and the miners. All of the students must negotiate sales while considering multiple mathematical models. They must try and sell all of their wares to make a profit, or use what little money they have to purchase all the gear they need, while also considering the money they will owe their investor, the merchant, which always includes a certain amount of interest added to the loan.

Summary of 4th and 5th Grade Content Standards for Gold

Standards Directly Addressed

Standard	Standard Language
HSS4.1	Demonstrate an understanding of the physical and human geographic features that define places and regions in California.
HSS4.2	Describe the social, political, cultural, and economic life and interactions among people of California.
HSS4.3	Explain the economic, social, and political life in Californian History
HSS4.4	Explaining how California became an agricultural and industrial power, tracing the transformation of the California economy and its political and cul-tural development.
4.OA	Operations and Algebraic Thinking **:** Use the four operations with whole numbers to solve problems.
4.OA.3	Solve multistep word problems posed with whole numbers and having whole-number answers using the four operations, including problems in which remainders must be interpreted. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding.
4.MD	Measurement and Data: Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit.
4.MD.2	Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale.
4.NBT	Number and Operation in Base Ten.
4.NF	Number and Operations – Fractions.
5.NBT	Multiplying Number and Operation in Base Ten.
5.NBT.7	Multiplying Number and Operation in Base Ten with decimals in the hundreths.
5.NF.6	Multiplying Fractions using Real-world problems.
SL4.1-6	Accomplishing objectives given through communication and cooperation, through critical thinking, active listening, problem solving, self-respect, teamwork, and leadership.
SL5.1-6	Accomplishing objectives given through communication and cooperation, through critical thinking, active listening, problem solving, self-respect, teamwork, and leadership.
L4-5.1-6	Demonstrating command of the conventions of standard English grammar and usage when writing or speaking, using knowledge of language and its conventions when writing,

	speaking, reading, or listening, and determine or clarify the meaning of unknown and multiple-meaning words and phrases.

Standards Supported

Standard	Standard Language
4-ESS2-2	Analyze and interpret data from maps to describe patterns of Earth's features.
5-ESS3-1	Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
5-LS2-1	Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
4-ESS3-2	Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.
RL4-8.1-10	Students gain adequate exposure to a range of texts and tasks. Students read increasingly complex texts through the grades.
RI4-8.1-10	Citing evidence, determining central text ideas and word meaning, analyzing how particular sections fit into overall text, tracing authors specific argument or point-of-view, and comparing and contrasting one author's presentation with that of another.
RF4-8.1-10	Develop students' understanding and working knowledge of concepts of print, the alphabetic principle, and other basic conventions of the English writing system.
W4-8.1-10	Students gain adequate mastery of a range of skills and applications. Each grade, students should demonstrate increasing sophistication in all aspects of language use, from vocabulary and syntax to the development and organization of ideas, and they should address increasingly demanding content and sources.