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Building Bridges in Earthquake Country: From the Past to the Present

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Introduction

In the Bay Area there are numerous bridges that are the key to our economic growth, transportation, and cultural diversity. Each morning I drive into San Francisco over the Bay Bridge to Alice Fong Yu K-8 Chinese Immersion School. In the evenings, I return to the East Bay via the Golden Gate Bridge and the Richmond-San Rafael Bridge. With five bridges connecting San Francisco to the East Bay as well as the Peninsula, one can expect an individual to travel over at least two to three bridges in a given day. Keeping that in mind, we live in Earthquake Country. The Richmond-San Rafael Bridge is an example of a cantilever bridge, whereas the Golden Gate Bridge and the Bay Bridge are examples of suspension bridges that have become world icons. But how many people truly know what type of bridge they are? Why are they built that way? These are the questions that I pose to my students.

The overall purpose of this unit is to integrate a unit on Bridge Building in Earthquake Country through the contact areas of; Earth Science, Language Arts, Technology, Ancient History, Art, as well as encompassing our seminars on ""Bridges: The Art and Science for Creating Community Connections"", by Martin Gehner. This approach will enable me to bring depth and application to the curriculum. In the area of Earth Science, the students will know that Earthquakes are sudden and that the amount of damage to a given area will depend upon numerous factors from the relationship to faults, the structural design, the magnitude, and the location of the epicenter. Living in California, the students will be able to explain how major features of California geology are a part of plate tectonics. In regards to earthquakes, students will be able to interpret how an earthquake can affect the types of construction in the Bay Area.

Being an educator in San Francisco Unified School District has enabled me to teach in a unique situation. The individuals that attend the schools in San Francisco are of a diverse ethnicity, which includes Chinese, African American, Filipino, Vietnamese, Caucasian, Japanese, Latino, Korean, and American Indian. Even though many of my students have been born and raised in San Francisco, many may have not even driven on or seen the various bridges in the Bay Area. These families tend to remain in their neighborhoods, never venturing out of San Francisco. The students that attend Alice Fong Yu K-8 Chinese Immersion learn Cantonese as a first language and Mandarin in the Middle School. From the outside world, this school is the first Chinese Immersion School in the Nation. Many individuals do not know what Immersion means? The students; African

American, Chinese, Latino, Caucasian, and Pacific Islanders attend this program without the ability to read, speak, and write in Cantonese and Mandarin. The students that attend the elementary division develop competency in the Cantonese language and use the two languages to actively and successfully access the curriculum. First the students learn to read, write, and communicate in Cantonese through the curriculum. On the first day a student enters kindergarten the student experiences 85% of the day in Cantonese, with only 15% is in English. Alice Fong Yu students are fully conversant and literate in both English and Cantonese by 5th grade. At Alice Fong Yu, the school curriculum (math, science, social studies, etc.) is taught primarily in Chinese during grades K-3, with an increase in English instructional time during 4th and 5th grades. (SFUSD) As the students move through the grade levels the amount of time that is allotted to the language decreases without sacrificing the format in which the immersion program has been successful. Alice Fong Yu students are fully conversant and literate in both English and Cantonese by 5th grade. By 5th grade the students can communicate effectively in Chinese and English, and have fulfilled the requirements to enter 6th grade. While the students enter 6th grade, they continue to learn Language Arts and Social Studies in English, whereas, this is the first time that the students have had a Science in English. The Chinese component in 6th grade includes Math, and Language Arts being taught in Cantonese. When the students enter 6th grade they have an additional language component of Mandarin. In order to accommodate Mandarin to complete our Immersion program we have extended the day for the Middle School students.

Along with the unique opportunities in teaching at a Chinese Immersion School, as an educator there are many opportunities to participate in summer science programs. My background in earthquakes has not just happened by experiencing earthquakes, but actually participating in a summer programs at Lawrence Berkley National Laboratory. The experience that was given to me, included illustrating faults in relationship to the Bay Area Bridges along with researching past Earthquakes that have affected the Bay Area.

My vast experiences have initiated my curiosity, knowledge and the connection to understanding the impact an earthquake can have on a community. In order for students to be as motivated and concerned for their community, I have designed a unit that will ignite the eagerness for the students to be an active participant in the connection of bridges being impacted by an earthquake in their community.

Objectives

My overall objective for this unit, ""Building Bridges in Earthquake Country: From the Past to the Present"" is to expand my student''s knowledge through the connection and the integration of Earth Science, Arts, Technology, Ancient History, Language Arts, as well in the area Physical Science. The centerpiece of the unit is the structural design of bridges being built in Earthquake Country. Using Bloom''s Taxonomy, this unit will address the critical thinker and the creative thinker.

In order for students to connect and apply the content areas, the student will demonstrate how the scientific method is being applied in inquiry-based labs. For example, in Station-D, the students will be making a hypothesis on what material would be better suited in building a bridge. The students will analyze the data to be used later in a poster presentation.

In Ancient History the students will be able to identify ancient civilizations that were crucial to the architecture in our present day bridges. The students will be able to identify the beam and arch as key components in bridge building. Along with this area of discussion, the student will locate communities and explain the adaptation that has taken place due to bridges. Then the students will demonstrate their knowledge by building a bridge. After building the bridge, the students will place the bridge upon the shake table (Raft). Using the shake table, the students will simulate a divergent plate boundary, convergent plate boundary, and a transform plate boundary.

In addition, the students will be able to design and apply content area of Earthquakes and bridges in a technology based activity. The students will design a bridge structure, which interacts with a real time earthquake simulated from either the Hayward or the San Andreas Fault. From the data that the students collected, the students will be able to explain how the epicenter, the magnitude of an earthquake as well as the soil can determine the type of bridge to be built in Earthquake Country.

In the impact activity, the students will demonstrate the ability to role-play as a decision maker through the processes of comparing, and contrasting through research, content, application, and data in real time debate. Last but not least, the students will summarize and collaborate their newfound knowledge through the application of a poster presentation.

Overall, in order for students to be motivated and concerned for their community the above objectives are essential to the growth in the knowledge and the application of building bridges in Earthquake Country. From this unit, we might just be inspiring our future engineers.

Strategies

When teaching Earth Science in California, we have an opportunity to educate student''s on earthquakes in the Bay Area. This enables the students the opportunity to be proactive and demonstrate their knowledge of the content in relationship of being prepared to survive an earthquake. What I have found over the years, it''s the reverse, many of my students as well as their families are complacent in earthquake preparedness. One such area that is extremely disturbing, is when a family purchases a home in San Francisco, knowing the cost of a home is astronomical; many families either do not have the funding, or feel that they do not want to spend the money to retrofit their homes. When we study earthquakes, we use an activity (FEMA) where we walk the neighborhood and identify key structural components outside of a structure that could lead to death, or complete destruction. As an extension to this lab, the students use a specific lab sheet (FEMA) where they have a place to illustrate their dwellings, and identify key structural elements that could be dangerous to their families as well as their neighbors. From this activity the students do a pair-share, about what they have learned about their dwellings, and discuss, and identify some solutions for their concerns. Many geologists and seismologists have said, ""Earthquakes do not kill people, but buildings do."" At this point, with the neighbor next to them, the students take their knowledge about earthquakes and design a structure using toothpicks and mini marshmallows. Then the students place their structure on top of a shake table. (Raft) The students simulate an earthquake; along with differentiating between the movements of various faults in the Bay Area. This would enable the students to have the opportunity to see hands on application in process.

After this event, the students within their larger groups would brainstorm and design a poster. This poster would demonstrate the student''s ability to analyze and respond to the following questions; structurally what they have learned? What could you have done differently? What were the strengths and weakness of your building? Along with responding to these questions, the students would generate new vocabulary as well as include a diagram that would be an overview of the student''s discussion in their group. At this point, the students would display their posters in the classroom, and then each student receives a set of yellow post-its, as well as blue post-its. With these post-its and without talking, the students walk around the classroom looking at the posters, as they look, the student''s generate questions on the blue post-its and place the blue post-its on the posters. On the yellow post-its, they would generate positive suggestions about the posters. The students then place the yellow post-its on the posters. When the students have completed their gallery walk, the students would respond to the questions that their peers have generated. But before any of the above activities or labs is done, we would have spent an extensive time going over the key concepts in studying Earthquakes.

Reflecting on what we have done previously in studying and teaching earthquakes, through the readings, and the seminars at Yale, that my unit called ""Bridge Building in Earthquake Country: From the Past to the Present: is quite applicable. While teaching 6th grade at Alice Fong Yu, teaching in a block schedule, there is a unique opportunity to teach this curriculum. Along with the scheduling, I teach three areas of concentration; which include Earth Science, Language Arts, as well Ancient History. After great thought and discussion, the first step into the process is how to disseminate all the new content on bridges that I have learned from the readings, research and seminars that were presented by Martin Genre, our professor, would be through a power point presentation. The power point presentation would demonstrate to the students that instruction and the new knowledge could be interactive.

As the research continued, other fellows in my seminar suggested, to add the connection of the local bridges in the Bay Area that include the following: Golden Gate Bridge, Richmond-San Rafael, Carquinez, Dumbarton, San Mateo, and the Bay Bridge. This connection would include the following areas of concentration from the visuals, history, design, and structure makeup of the bridge. Along with the local interests, select bridges that can be identified structurally in Ancient History. Last but not least, what is essential to tie in, is the impact a bridge can have on a city or country economically as well as culturally when a natural disaster, like an earthquake occurs. Students as well as adults tend to not look at these factors, and the students miss the opportunity to study how a bridge can impact a region.

The bridge building could either be an extension after building structures, or a centerpiece of structural design in Earthquake Country. The process of building a bridge enables the students the opportunity to put to work their knowledge of the components of an earthquake, along with the structural designs that encompass architecture and engineering of a bridge, as well the historical earthquake history of the bay area. The bridges in Bay Area represent not just transportation, but the link to economics as well as the cultural diversity of our great city.

Teaching this unit, ""Building Bridges in Earthquake Country: Past to the Present"", gives the educator the flexibility and the opportunity to use various teaching strategies. Depending on the content they teach, as well as the time they have allotted in a school calendar, the whole unit or just a portion could be presented. In the organizational process of this unit, the unit would be integrated into the Earth Science curriculum, with the ability to tie in the other areas of concentration. The concepts and terms in Appendix 1 are essential in making this unit applicable to the student. This unit could be approximately a ten-day lesson plan, which will motivate and hopefully inspire the next generation of engineers. While reflecting on the seminars, literature, and the application, Physical Science could be easily integrated into the unit. Within this unit there is the flexibility of doing whole group, pair share, small group or to have stations situated around the classroom. Reflecting on one''s own classroom management, this is essential part of your decision making process of initiating this unit on Bridges. Besides classroom management, the other concern would be the cost of the items as well as where to locate these items for the labs and activities. Keeping that in mind, a lot of thought and surveying costs were placed in the process of these activities and labs. One would say ""Target"", ""Wal-Mart"", or the ""Dollar Store"" as your choice of shopping. Another area of concern will be in the meeting the needs for special need children as well as English language learners. The lessons address through the process of instruction, instructional activities, as well as labs to meet their needs. The last area of concern lies with the availability of technology. In the unit there are four areas where computers will be used; in the application of building a bridge, researching, designing, simulating, and in teacher presentations. If the teacher does not have a computer, a computer lab, or computers in the classroom they will have difficulty in completing the whole unit.

Yet again I found myself reflecting on my Special Need Students, Gifted, as well as the English Language Learners when developing the unit on Bridge Building in Earthquake Country: From the Past to the Present. In order for this unit to be successful there is a need to integrate specific strategies to address the language learners and the special need student in the areas of writing and vocabulary. A ""Quick Write"", would help identify the student''s background knowledge on bridges as well as identifying the key terms and vocabulary that will be essential for the students to be successful. After introducing the key terms and vocabulary through activities, labs, and research, I have put together a ""Building Bridges Vocabulary Jigsaw"". This vocabulary activity will help the student''s with spelling, pronunciation, as well in definition of the terms. But when you look at these Language Arts activities, as an educator they are just great teaching strategies. Keeping that in mind, all the students will benefit.

Reflecting on station driven curriculum, there are factors that need to be addressed. The first of course is in classroom management. When looking at this aspect, one needs to be honest with looking at you as the facilitator. Do you have a structure? What are your expectations? There is structure in everything. The second step would be in looking at your class. Honestly, there are times no matter how the teacher tries to train the students to work independent, but with movement, it just does not work. Another area of concern could deal with the time frame of your curriculum. As a teacher that has a block schedule, I found that using station driven activities and labs have been successful for the students. This teaching strategy fosters independence, leadership as well as gives more flexibility to interact with the students.

Lessons 1-Stations A-G

After addressing the Language Arts in this curriculum, my focus turned to the Arts, Earth Science, as well as Ancient History in the Bridge Building Stations. At Station-A, the students will be introduced to the beam. There will be a laminated piece of cardstock. The cardstock will contain the objectives and the directions of the activities that the students will be completing at this station. There will be a comprehensible definition of the term. The activities will encompass the arts, earth science, as well as ancient history of the beam. At Station-B, the students will be introduced to the arch. There will be a laminated piece of cardstock. This cardstock will contains the objectives, and the directions of the activities that the students will be completing at this station. There will be a comprehensible definition of the term. Once again, the activities will encompass the arts, earth science, as well as ancient history. At Station-C, the students will be introduced to a variety of websites that are aligned to technology and bridge building. There will be a laminated piece of cardstock. The cardstock will contain the objectives, as well as the directions of what is expected and required at this station. The students will have a scavenger hunt activity regarding the various websites that encompass engineering as well as bridges. At Station-D, the students will be introduced to materials. There will be a laminated piece of cardstock. The cardstock will contain the objectives, as well as the directions of the activities that the students will be completing in this lesson. At this station, the students will be analyzing various materials in relationship to building bridges. A data sheet will be provided in order to interpret their data. At Station-E, the students will be introduced to Suspension. There will be a laminated piece of cardstock. The cardstock will contain the directions, the objectives as well as the lesson. There will be a comprehensible definition of the term. Once again, the activities will encompass, the arts, earth science, as well as ancient history. At Station-F, the students will be introduced to Cantilever. There will be a laminated piece of cardstock. The cardstock will contain the directions of the activity or lab, as well as the objectives of this station, as well as the lesson. There will be a comprehensible definition of the term. The activities will encompass, the arts, earth science, as well as ancient history. At Station-G, the students will be introduced to Local Bridges. The following bridges will be included at this station: Golden Gate, Bay Bridge, Richmond-San Rafael, Carquinez, Dumbarton, and the San Mateo Bridge. There will be a laminated piece of cardstock. The cardstock will contain the directions, the objectives of the station, as well as the lesson. The station will include the history, and the structural design of each bridge. When the students have completed these stations they are on the first step of becoming an engineer of bridges.

Lesson 2-Project Based

The next step in the process of becoming an engineer is in the project-based activity-building a bridge. The students will be given directions as well as a rubric to this activity. The students will team up with a fellow student. As the student''s read their directions to the project-based activity (Appendix-4), they will identify some strict guidelines. One, they are given money to purchase their materials. The materials include the following; graph paper for their design, a ruler, clay, popsicle sticks, etc. They are also given an expense sheet to keep their data on how much they used of the materials as well as the cost. Second, they have to get the city planner to sign off on the structural design of the bridge. Keep in mind, in the directions, they are told how tall and how wide their bridge can be, if it will service pedestrians, vehicles, or trains as well as where it is going to be located. The city engineer is the teacher. Once everyone has been signed off, the students can begin building. Using a watch, in the directions, the students are to keep time on how long it took to build their bridge. The city planner (the teacher) calculates time. If they go over the time allotment, the builders are charged. As they are charged, for using too many pieces, or too less of structural pieces. When this process is complete, the students will share what type of bridge they built with their fellow classmates. The test will be placing the bridge structure on top of the shake table. (Raft) As we did in the lab for building a structure, we will simulate an earthquake. This process will be timed in relationship to various earthquakes that have taken place in the bay area. The students will be able to identify the bridges that could withstand an earthquake, and discuss various solutions to the problems. While this lab gives simplicity of what will happen, it cannot accurately generate a magnitude earthquake. That aspect of this lab has always concerned me.

Lesson 3-Technology Based

But while doing my research I found the website called Bridge to Classroom: Engineering for Earthquakes. This website not only gives the students the opportunity to build the bridge, but gives them a variety of choices with explanations. Along with the various structures, the student can select various ways to support the structure. After the student selects the bridge design with support, he or she can print a copy of the structure. The next step is to choose either the San Andreas Earthquake or the Hayward Earthquake. Then select the magnitude of the earthquake. The website will actually simulate the earthquake with the magnitude. When the earthquake is complete, it will show the structural flaws as well as give you reasons for the destruction. The student will have the opportunity to print out a visual of what happened to their bridge design. Until now I have never found a real time interactive website where you can put in a bridge design as well as the magnitude of an earthquake. The feedback that the students receive is quite essential for the process of understanding how to build and live in earthquake country. The activity gives the students the opportunity to compare and contrast the data that they have collected. The students will use the data in the evaluation Lesson-5 using a poster presentation to fellow students.

Lesson 4- Project Based

The impact activity will demonstrate the ability to role play as a decision maker as well as involve the students'' ability to process the content, the research, and in the application of Bridge Building in the Bay Area. Presently there is a new Bay Bridge being built, but prior to the build, there was much controversy. There was a power struggle between to the two city Mayors of Oakland as well as San Francisco. The concerns lied with the cost of the bridge; design, the impact on transportation, as well as how it was going to affect Treasure Island.

In order for students to make the connection to the concerns and issues in building the bridge, the teacher will need to introduce a ""debate"". In Language Arts as well as in Social Studies, this teaching strategy is widely used. The teacher will give the students an example, Should students have the ability to purchase a soda on campus? The teacher will give each child the question in a ""Quick Write."" The students will generate the pros as well as the cons of purchasing soda on campus. This activity will lead to two students the teacher has selected to share the positive and negative of this idea through a debate. Then the teacher would have the students to take a vote on whether there should be the ability to purchase soda on campus.

After doing this basic activity, the teacher will move the students to past concerns as well as issues of the new Bay Bridge. In order to make the connection, each student will select a role. The roles relate to the government, concerned citizens, individuals that are responsible in building the bridge. I have designed cards, which are made out of cardstock, with the role of the individual, as well as a small description of that role. The following roles include; the citizens of San Francisco, citizens of Oakland, the Mayor of San Francisco, the Mayor of Oakland, an advisor from the EPA, an Archeologist, a Contractor, an Iron worker, a member of the Sierra Club, a Design Engineer, and a Safety Manager.

Each student will randomly select a role. The guidelines for this activity include that each student will use the basic information, then research information they will need for their role and decide how they would present the information of building the Bay Bridge. The individuals that were selected, as concerned citizens will first work individually then they form a group to share their ideas. As the teacher, I will participate as a TV anchor that is going to moderate the debate.

There will be a long table established in the front of the classroom, for the individual role players to sit. The setup at the table will include name cards with the roles that the students are playing. The concerned citizens will sit in the audience. Let the debate begin.

As with any debate on a public item of this magnitude, the final act will be that the students exercise their right to vote. This vote will be to either build the bridge or not build the bridge. This activity will give the student opportunity to generate and research the political process, as well as to experience oral presentations as objectives to be achieved.

Lesson 5-Evaluation

The final activity will be the students designing a poster that summarizes what the students have learned from Building Bridges in Earthquake Country: From the Past to the Present. First, there will be no more than six students in each group. Each student will select one colored marker to use on the poster. The students will be given an activity sheet, which will include a variety of questions that will guide the students in summarization of this unit. As a group, the students will begin to answer the questions and include illustrations in a rough draft format.

One of the questions addresses an illustration. The illustration will be taken from one of the structural bridges that were built among the team members. The students will label the illustration. The second question addresses vocabulary. The group will select five new terms that they would like to place on the poster. Along with the selection, the students will summarize definitions to go along with the vocabulary. The third question will reflect the history of a Bay Bridges. This question will relate to the process of building as well as the materials that were used in a local bridge. The fourth question will demonstrate questions that the students still have in regards to bridges. The group should list on the poster at least three new questions, but no more than five questions. The fifth question is taken directly from the data collected from the technology-based activity. The group will share their data, and add a diagram that summarizes their data. The last question is a three to five sentences that summarize the unit on Building Bridges in Earthquake Country: From the Past to the Present.

The students will place the posters around the classroom. Each student will be given a blue post-it and a yellow post-it. With these post-its and without talking, the students walk around the classroom looking at the posters, as they look, the student''s generate questions on the blue post-its and place the blue post-its on the posters. On the yellow post-its, they would generate positive suggestions about the poster. When the students have completed their gallery walk, the students will then respond to the questions that their peers have generated.

In this culminating activity I would give each student a certificate that states that they have demonstrated through labs, activities, and role-playing as decision makers, are now an engineer that can build a bridge to withstand the Big One. Now when I ask my students the following questions: Why are the local bridges built that way? What type of bridge did you cross over? They will be able to respond and identify, as well as being able to reflect how living in Earthquake Country can affect the community one resides in. '

Appendix 1

In order to teach this unit, an educator will need to address the following concepts and terminology to have a unit that is affective and connected to the purpose of this unit.

Alfred Wagener- He is remembered for his contribution to geology, for the theory of the continental drift. He named and described Pangaea and provided strong arguments as a supercontinent. He was not the first to recognize the separation of the continents, but he was the individual, that till his death tried to prove his theory.

Harry Hess-He was a professor of geology at Princeton University. Even when serving in WWII, he conducted research-using sonar. He was very influential in setting the stage for the emerging plate-tectonics theory in the early 1960s. He believed in many of the observations Wegener used in defending his theory of continental drift, but he had very different views about large-scale movements of the Earth. He said that the evidence came from the mapping of the sea floor. (due to WWII submarines)

Pangea- meaning "all earth" supposedly covered about half the Earth and was completely surrounded by the ocean. It then began to break apart. The movement of the continents took millions of years to be where they are today.

Plate Tectonics Theory- This theory is considered a relative new theory. Alfred Wegener proposed this theory in 1915. The theory is stated that the Earth is broken up into large plates. The size and the proportion change over time. Where the plates move against each other, one will usually find intense geologic events: volcanoes, earthquakes, and mountain building.

Sea Floor Spreading**-**In the theory of plate tectonics, the process by which new oceanic crust is formed by the convective upwelling of magma at mid-ocean ridges, resulting in the continuous lateral displacement of existing oceanic crust.

Continental Drift-The movement, formation, or re-formation of continents described by the theory of plate tectonics. It is referred to the movement of the Earth''s Continents.

Transform Plate Boundaries -This boundary is located where two plates slide past one another. The fracture zone that forms a transform plate boundary is known as a transform fault. Most transform faults are found in the ocean basin and connect offsets in the mid-ocean ridges. A smaller number connect mid-ocean ridges and seduction zones.

Convergent Plate Boundaries- This boundary is located where lithosphere plates are moving towards one another. The plate collisions that occur in these areas can produce earthquakes, volcanic activity and crystal deformation.

Divergent Plate Boundaries- This boundary is located where plates are moving away from one another. This occurs above rising convection currents. The rising current pushes up on the bottom of the lithosphere, lifting it and flowing laterally beneath it. This lateral flow causes the plate material above to be dragged along in the direction of flow. At the crest of the uplift, the overlying plate is stretched thin, breaks and pulls apart.

Strike-Slip Fault**-** The strike faults are either right or left laterals. The fault ruptures as the ground generates vibrations-or waves-in the rock that we feel as ground shaking. Faults are weaknesses in the rock and therefore earthquakes tend to occur over and over along the same faults. For strike-slip faults, the rupture is nearly vertical and during an earthquake one side slides past the other. The San Andreas Fault is a strike-slip fault formed where two parts of the earths crust (plates) slide past each other.

Reverse Faults- This type of fault forms when the hanging wall moves up. The forces creating reverse faults are compressional, pushing the sides together.

Normal Fault-This type of fault forms when the hanging wall drops down. The forces that create normal faults are pulling the sides apart, or extensional.

Primary Waves-Another name for this wave is-P waves or compression waves. The P- waves are the first to arrive at the surface during an earthquake. They can travel through solid, liquid and gas, and so will pass completely through the body of the earth. As they travel through rock, the waves move tiny rock particles back and forth—pushing them apart and then back together—in line with the direction the wave is traveling. These waves typically arrive at the surface as an abrupt thud.

Secondary Waves-Another name for this wave is-S waves or shears waves. They actually lag a little behind the P waves. As these waves move, they displace rock particles outward, pushing them perpendicular to the path of the waves. This results in the first period of rolling associated with earthquakes. Unlike P waves, S waves don''t move straight through the earth. They only travel through solid material, and so are stopped at the liquid layer in the earth''s core.

Love Waves-Another name for this wave is-L waves. They are actually secondary waves but they movesidetosideinsteadof upanddown.

Mercalli Scale- this scale was incise away to measure the strength of an earthquake. Invented by Giuseppe Mercalli in 1902, this scale uses the observations of the people who experienced the earthquake to estimate its intensity. The Mercalli scale isn''t considered as scientific as the Richter scale. Some witnesses of the earthquake might exaggerate just how bad things were during the earthquake and you may not find two witnesses who agree on what happened; everybody will say something different. The amount of damage caused by the earthquake may not accurately record how strong it was either.

Richter- This type of measurement was invented by Charles F. Richter in 1934. The magnitude of most earthquakes is measured on the Richter scale, invented by Charles F. Richter in 1934. The Richter magnitude is calculated from the amplitude of the largest seismic wave recorded for the earthquake, no matter what type of wave was the strongest. The Richter magnitudes are based on a logarithmic scale (base 10). What this means is that for each whole number you go up on the Richter scale, the amplitude of the ground motion recorded by a seismograph goes up ten times.

Liquefaction- Liquefaction is a phenomenon in which the strength and stiffness of a soil is reduced by earthquake shaking or other rapid loading. Liquefaction and related phenomena have been responsible for tremendous amounts of damage in historical earthquakes around the world. Liquefaction occurs in saturated soils, that is, soils in which the space between individual particles is completely filled with water. This water exerts a pressure on the soil particles that influences how tightly the particles themselves are pressed together. Prior to an earthquake, the water pressure is relatively low. However, earthquake shaking can cause the water pressure to increase to the point where the soil particles can readily move with respect to each other.

Truss- There is a variety of trusses that can be identified in numerous bridges throughout the world.

King Post Truss-It is the simplest form. This truss has been adapted to support shorter bridge spans.

Queen Post Truss-It actually adds a horizontal top chord to achieve a larger span.

Lattice Truss-It is easy to construct, but labor intense.

Vierendeel Truss-It is a rectangular system of structural elements capable of transferring loads by imposing bending moments on all structural elements.

Arch-It is intriguing in that they are truly a natural form of bridge. It is the shape of the structure that gives it its strength. An arch bridge requires end supports or abutments.

Beam-This bridge is basically a rigid horizontal structure that is resting on two piers, one at each end. The piers directly support the weight of the bridge and any traffic on it. The weight is traveling directly downward.

Cantilever-A projecting beam or member supported at only one end: as a:a bracket-shaped member supporting a balcony or a cornice b:either of the two beams or trusses that project from piers toward each other and support a suspended connecting member.

Suspension-A suspension bridge is one where cables (or ropes or chains) are strung across the river (or whatever the obstacle happens to be) and the deck is suspended from these cables. Modern suspension bridges have two tall towers overwhich the cables are strung. Thus, the towers are supporting the majority of the roadway's weight.

Tension- It is a force that acts to expand or lengthen the object on which it is applied.

Compression- It is a force that acts to compress or shorten the object on which it is applied.

Appendix 2

Bibliography and Resources

Internet Resources:

http://www.pbs.org/wgbh/nova/bridge/ (accessed July 12. 2008).

Interactive approach to bridge building. Comes with a teacher resource guide.

http://www.newbaybridge.org/classroom/engineeringfor.html (accessed July 13, 2008).

The interactive approach to building a bridge in the East Bay with the ability to simulate an earthquake from either the Hayward or the San Andreas Fault.

http://www.nationalgeographic.com/forcesofnature/interactive/index.html (accessed July 12, 2008).

This gives the student the opportunity to look at case studies, map, as well as participating in a lab the will enable the students the ability to apply their knowledge.

http://dsc.discovery.com/guides/planetearth/earthquake/interactive/interactive.html (accessed July 13, 2008).

This gives the students the ability to apply their knowledge of earthquakes, as well as see and hear research on the great 1906 earthquake.

http://www.pbs.org/wgbh/buildingbig/bridge/index.html (accessed July 11, 2008).

Interactive website as well as resourceful for students studying bridges.

http://www.exploratorium.edu/ (accessed July 13, 2008).

Great resource for teachers and students on activities related to earthquakes as well as bridges.

http://www.teachingboxes.org/index.jsp (accessed July 13, 2008).

This website in designed by and for teachers that need resources and clarification on concepts and terms associated with Plate Tectonics and Living in Earthquake Country in toolboxes.

http://www.fema.gov/kids/femapub.htm (accessed July 13, 2008).

Seismic Sleuths-A teacher''s package for 7-12 grade students.

0-122 Fema 253 (Free)

http://www.sfgate.com/greatquake/ (accessed July 12, 2008).

This website gives the educator as well as the student the resources as well as data on the 1906 Earthquake.

http://www.raft.net/ideas/Shake%20Table.pdf (accessed August 9, 2008).

This website is the directions as well as the design of the shake table.

http://education.usgs.gov/common/primary.htm#earthquakes (accessed July 11, 2008).

The resources from the USGS, enables students the opportunity to interact, post data of an earthquake, as well ask a geologist if they have a question.

http://1868alliance.org/ (accessed July 11, 2008).

The anniversary of the Hayward Fault Earthquake. This enables the students as well as teachers to receive up to date information.

http://www.sciencedaily.com/releases/2007/12/071214001612.htm (accessed July 11, 2008).

This website includes new data as well as past information on the Hayward Fault. This enables the students to research the fault as well as put the knowledge to task for the student''s project.

http://web.ics.purdue.edu/~braile/indexlinks/educ.htm (accessed July 11, 2008).

Dr. Braille''s curriculum (which is free domain) is easy to use and include in the instructions of plate tectonics, earthquakes. The labs are easily accessible as well as a way to connect to bridge building to Earthquake Country.

Children's Books:

Mann, Elizabeth, and Alan Witschonke. *The Brooklyn Bridge: The Story of the World''s Most Famous Bridge and the Remarkable Family*, That Built It. New York: Mikaya Press, 2006.

This book explains the history of the family behind building the Brooklyn Bridge. The process includes the struggles and the concepts behind the structural design of the bridge.

Sturges, Philemon and Giles Laroche. *Bridges are to Cross*. New York: Penguin Young Readers Group, 1998.

Looking at the Golden Gate Bridge, Segovia Aqueduct, from the old to youngest bridge.

Bunting, Eve. *Pop''s Bridge.* New York: Harcourt Inc., 2006.

This book is through the eyes of a child whose father is building the Golden Gate Bridge.

Seymour, Simon. *Bridges*. San Francisco: Chronicle Books, 2005.

This book includes structural designs from the beams, arches, history, to the illustrations, for elementary students.

Seymour, Simon. *Let''s Try it out with Towers and Bridges: Hands-On Early Learning Activity.* New York: Simon & Schuster, 2003.

This book designed for young learners, it is beneficial to the hands on approach for bridge building.

Wiese, Jim. *Ancient Science.* San Francisco, CA: Jossey-Bass A Wiley Imprint, 2003.

This book integrates Ancient Science with History through applications.

Karwoski, Gail Langer. *Quake! Disaster in San Francisco, 1906*. Atlanta, Georgia: Peachtree Publishers, 2006.

This middle school historical fiction follows a family through the struggle of the 1906 earthquake.

Christian, Spencer and Antonia Felix. *Shake, Rattle, and Roll*. New York: John Wiley & Sons, 1997.

This book is a great resource for teachers and students.

Earthquake Resources:

Bolt, Bruce. *Earthquakes and Geological Discovery.* New York: Scientific American, 1993.

This book guides an individual on geology and the relationship to earthquakes.

Dixon, Douglas. *The Practical Geologist.* New York: Simon & Schuster, 1993.

This book is designed to give the basic concepts of geology to a novice.

Bronson, William. *The Earth Shook, The Sky Burned.* San Francisco: Chronicle Books, 1959.

This book gives great historical detail to the 1906 Earthquake.

Jacopo, Robert. *Earthquake Country*. Tucson, Arizona: Fisher Books, 1996.

This book enables individuals understand the various terms and concepts related to living in earthquake country.

Yanked, Peter. *Peace of Mind in Earthquake Country*. San Francisco: Chronicle Books, 1991.

This book is essential in living in Earthquake Country.

Kerman, Dan. *Disaster! The Great San Francisco Earthquake and Fire of 1906*. New York: Harper Collins, 2001.

Historical looks at the 1906 earthquake, which will help the reader, understand living and building in the Bay Area.

Yeats, Robert. *Living with Earthquakes in California, A Survivor''s Guide*. Corvallis, Oregon: Oregon State University Press, 2001.

A great resource in living in Earthquake Country; building structures, liquefaction, etc.

Appendix 3

California State Objective for:

The California Earth Science Standards that will be addressed in the unit will be addressed include the following:

1. Plate tectonics accounts for important features of Earth''s surface and major geologic events. As a basis for understanding this concept:

d. Students know that earthquakes are sudden motions along breaks in the crust called faults and that volcanoes and fissures are locations where magma reaches the surface.
e. Students know major geologic events, such as earthquakes, volcanic eruptions, and mountain building, results from plate motions.
f. Students know how to explain major features of California geology (including mountains, faults, volcanoes) in terms of plate tectonics.
g. Students know how to determine the epicenter of an earthquake and know that the effects of an earthquake on any region vary, depending on the size of the earthquake, the distance of the region from the epicenter, the local geology, and the type of construction in the region.

7. Scientific progress is made by asking meaningful questions and conduction careful

Investigations. As a basis for understanding this concept and addressing the content in other three strands, students should develop their own questions and perform investigations. The students will be able

1. Develop a hypothesis.
2. Select and use appropriate tools and technology (including calculators, computers, balances, spring scales, microscopes, and binoculars) to perform tests, collect data, and display data.
3. Construct appropriate graphs from data and develop qualitative statements about the relationships between variables.
4. Communicate the steps and results from an investigation in written reports and oral presentations.
5. Recognize whether evidence is consistent with a proposed explanation.

The California Social Studies Standards that will be addressed in this unit include the following:

6.1.2 identify the locations of human communities that populated the major regions of the world and describe how humans adapted to a variety of environments.

6.7.8 discuss the legacies of Roman art and architecture, technology and science, literature, language, and law.

The California Technology/ Language Arts Standards that will be addressed in this unit include the following:

1.4Use organizational features of electronic text (e.g. bulletin boards, databases, keyword searches, e-mail addresses) to locate information.

1.5Compose documents with appropriate formatting by using word-processing skills and principles of design (e.g., margins, tabs, spacing, columns, page orientation).

The California Visual Arts Standards that will be addressed in this unit include the following:

1.1 Identify and describe all the elements of art found in selected works of art (e.g., color, shape/form, line texture, space, value).

1.4 Describe how balance is effectively used in a work of art (e.g., symmetrical, asymmetrical, radial).

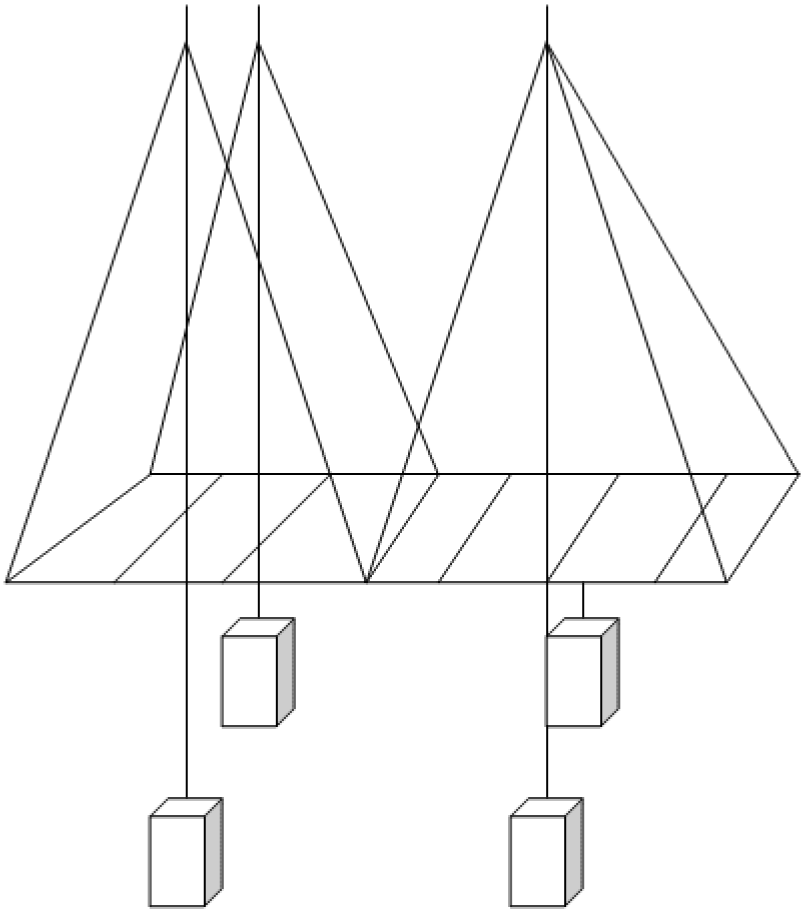
Appendix 4-Bridge Building Project

Objectives:

- The student will demonstrate the ability to apply the knowledge of various bridges in a model.
- The student will demonstrate to the ability to reflect this lab in a ""Quick Write"".
- The student will demonstrate the application of placing the bridge on a shake table (Raft) to simulate an earthquake.

Materials:

- Craft Glue
- Modeling Clay
- Short Popsicle Sticks
- Standard Popsicle Sticks
- Scissors
- Colored Pencils
- Graph Paper
- Rulers



The Diagram to the right is just an example of a possible bridge.

Directions:

First-

1. The students will need to work with the partner on their right.
2. The students will need colored pencils, ruler, and graph paper.

Second-

1. The width of the bridge no wider than 6 inches. The height from the base no taller than 10 inches from the base. The length of the bridge no longer than 12 inches.
2. The students will illustrate their design on the graph paper a bridge to be built.
3. The students will then proceed to get the supplies that are needed to build their bridge.
4. When they have completed their bridge building, they will place the bridge on two shake tables.
5. Then the students will simulate an earthquake.
6. In a reflection that was given to the students, they will respond to a few questions on their experience on bridge building and what they have discovered from this lab.