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Building Bridges Over Turbulent Middle School Waters

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Introduction

This curriculum unit examines the role of art in bridging the gap between school and community by using local bridges as a metaphor, and as actual structures of importance throughout neighborhoods. The curriculum will help students understand the diverse nature of the community where they live. The school is conveniently located within easy walking distance of many roadway bridges which have recently undergone reconstruction. The work to replace and repair several of these bridges caused great changes in the traffic patterns in the surrounding neighborhoods. Many parts of the community were impacted. Road closures lasted as long as a year. The importance of timely completion of these projects became very clear to members of the community as walking and driving times lengthened and new traffic routes had to be established.

As students look at the problems which arise when reconstruction starts, they will also study the rather lengthy planning process the community must go through before any of the actual bridge work begins. They will learn that the process is very complex and is filled with controversy, particularly for art work on any of these bridges. We will study issues as large as cost and placement of newly built bridges, and issues as small as color selection. Students will examine the reasoning behind the upkeep of bridges of historical interest. Architects, engineers, and city planners can help with these explanations, and we will enlist the help of City of Santa Fe Public Works staff and representatives from the various trades involved in creating these structures. Some of the small bridges we will study have a great deal of steel ornamentation, stone masonry, and concrete. We will discuss with a consultant from the Santa Fe Arts Commission the process of selecting materials, based on factors such as looks, maintenance requirements, and availability.

The students should understand the Arts Commission's role in each bridge's process. The Arts Commission within the Public Works branch of the City of Santa Fe, ultimately decides what art work will be placed on bridges or anywhere else in the city. The Arts Commission puts out the initial call to local artists in New Mexico to submit ideas and designs which might be incorporated into any new, replaced or repaired bridge. Selected artists begin to work with the Arts Commission's design team of architects, engineers, arts commissioners, and a contractor. The team has many questions to answer as it proceeds through the planning phase. One of the first things the team examines is the purpose of the bridge, and why it needs creation, replacement or repair. Does the bridge need to keep cars safe, or is the primary purpose to keep people safe?

Many roadway bridges over the Santa Fe River and the city's many arroyos are concrete box beams, although

some are box culverts. Most of the spans throughout the city are less than one hundred years old and built with concrete. Many were built in during the depression era. Recently, city road inspectors determined that one of the concrete bridges is in great need of repair. It is basically one large slab, reinforced with steel. The structure has moved and settled enough to make it increasingly unstable. Pre-stressed concrete methods used today were not employed in the original bridge. This is a wonderful opportunity for students to observe a design team analyzing the design and construction elements of a new bridge. Proposals for the design of the new bridge have already been submitted to the design team.

There is a great deal of public input and concern when the railings and fascia on bridges are chosen. We will study a bridge for which the Commission design team has chosen a local artist who does a lot of work with the public schools. Students will meet this artist and discuss with her the process for creating art work for the bridge. She will describe the public's concern that the bridge be constructed in such a manner as to blend in with the surrounding city park, giving particular attention to appropriate symbolism which might be displayed. Many revisions to the original drawings were made. Compromise is often required of all parties in order to complete public projects.

Historical Background

Bridges are structures that have been on the planet as long people have existed. When you think about it, bridges occur in nature all the time. The simplest version of a bridge that comes to mind would be a tree that has fallen across a small creek or a dry wash. Bridges also occur naturally made of stone. Here in the southwest these bridges are created in sandstone that has been eaten away by running water, and may have taken thousands of years to form.

One can imagine a chipmunk or squirrel running across the downed tree from one side of a creek to another, or a mountain lion walking slowly across a stone arch as it stalks its prey. One can easily imagine people doing the same thing, stepping carefully across a tree bridge, bouncing a little at the mid point of the span. People would have to balance themselves carefully, moving slowly to cross over a stone arch. In fact as long as people have existed they have been using bridges that occur naturally, and subsequently they have used the ones specifically built for human use.

The earliest people living in New Mexico the Paleo Indians, would have used bridges when they found them. They were a nomadic people, hunters of big game over fifteen thousand years ago. They lived by following the game herds. One may picture people using fallen trees or even stepping stones in small creeks as bridges to help move across the landscape. Did people actually make bridges in ancient times? There is not a lot of archaeological evidence to tell if they did or not. We do know that people used stone implements, spear points, arrow tips, knives, adzes, axes, and scrapers. These were extremely sharp tools. However these stone tools lacked much tensile strength; they were very brittle. With a great deal of effort a person could have cut down small trees with a stone adze, but nomadic people might not take the time to build a bridge. This time consuming-exercise would take away valuable hunting time. Besides, people were probably not in the area long enough to use the bridge much, as the game was always moving and people would be forced to follow.

Eventually the Paleo Indians settled down into permanent villages called pueblos. The Ancient Pueblo Peoples learned to plant corn, squash, and beans. Often the fields were planted some distance from houses made of

stone, mud, and wood. Daily travel to and from the fields may have led to the creation of bridges over local creeks and ravines. These bridges, built some two thousand years ago, were probably not much more than a log or two placed beside one another. This placement created a simple way to make a crossing. Using a large flat stone would also have been effective. Again, we have no real proof that either of these methods were used, it is simple speculation based on what we have seen people do in modern times.

More recently photography gives us an insight into how bridges in the area may have been built. There is an interesting picture taken on the Rio Grande around the turn of the century. In the photo are several men from San Ildefonso Pueblo working on what appears to be a bridge across the river. They created a series of woven willow cylinders, about three feet in diameter. Each cylinder is probably about eight feet long, depending on the depth of the river. These have been placed in a line perpendicular to the bank of the river, about seven or eight feet apart. The cylinders are filled with stones and extend about two feet above the water line. Each cylinder is connected by two or three tree trunks laid horizontally, the ends resting on the adjacent cylinder. It is a crude, but effective way for people to cross the nearly two hundred feet of river. This method of using piers made from stone-filled cribs to hold up simple beams is a method that was used and developed by many cultures around the world. The bridge on the Rio Grande probably washed away each May during the spring run off, and rebuilt sometime later in the summer when the waters subsided. How long ago was this technology used to span the river? We have no way of knowing. We do, however, have archeological proof that many traditional crafts and building techniques used two thousand years ago are still being used today in the Pueblos.

Three thousand years ago the Trojans built bridges to serve the citizens of Troy. The post and beam style of bridge was one of the first styles type they developed to span rivers. Cribs of wood were constructed during low water conditions with upright posts in the center. The cribs were filled with stones. The distance of the cribs was determined by the length of the beams that would be attached to the tops of the piers. The horizontal placement of the beam would be determined by the height of the banks on either side of the river. Cross beams between the vertical piers helped to hold up the longer spanning beams. Instead of placing the beam ends directly on the banks, stone abutments were constructed on both sides of the bridge, making the ends of the bridge much more stable. Once all bracing was finished, a wearing surface (deck to walk on) was made by pegging planks across the long beams. This kind of bridge may have lasted for a while, but it was still subject to seasonal flooding and would require lots of maintenance and rebuilding.

In some areas of the world, the abundance of large, flat stones has been the building material of choice. "Clapper" bridges can be found in England which might be considered prehistoric in origin. We can only speculate about this, but it is generally considered to be a very early form of beam construction used by builders several thousand years ago. Stone piers placed in shallow rivers carried horizontal stone members. This created a simple, sturdy form of bridging which held up to the winter ice and spring floods. Many of these remain in existence today throughout the world.

The Romans left an abundance of written and physical evidence showing their superior bridge building abilities. Two areas to look at are the development of cofferdams for foundations and the extensive use of the arch. The placement of solid piers in the moving water of rivers has always been a major challenge for bridge builders. The Romans developed a process for building cofferdams (foundations for piers). An oblong ring of wooden stakes was driven into the bottom of the river. A second ring of stakes were driven into the river a short distance inside from the first ring. The space between the stakes was then stuffed with wicker baskets filled with clay. Once the timber walls were made water tight with clay and reeds, the water inside the circle was emptied.

The floor of the cofferdam was then dried, and the earth dug out until solid rock was uncovered. If the bottom was soft mud, a mass of wooden stakes would be placed, driven down to form a solid flat surface. The cofferdam was then filled with pozzolana, a water- proof cement made by mixing water, lime, sand, and rock. This concrete mixture could be poured into the wooden staked form. The chemical reaction that occurred left a solid, smooth surface on which large stone blocks could be placed to continue the construction of piers. These piers would then carry the arches of the bridge. The foundations did not always stay in the position intended to, causing the bridge to fail and eventually be torn down or destroyed during floods. Many of the bridges built on these foundations did survive and are still in existence today, 2000 thousand years later. The methods and materials used in Rome are very similar to the techniques used by modern builders around the world today. The methods for making and transporting the concrete have improved; the application of the material has remained the same.

With the foundations in place the Romans then built piers of stone to the required height. The builders then used semi-circular arches to span the individual piers. The Romans made extensive use of the arch. Most of those structures are bold and impressive. The Sumerians and the Egyptians knew the principles of the arch. They built many tombs and buildings using corbelled arches and semi-circular arches. The Romans, however, used semi-circular voussoir arches extensively in bridges all over Europe. The Romans made voussoirs by cutting stone into wedge shapes and placing them in the semicircular arch.

Another unusual feature found in eleven of the bridges leading into Rome was not how they were built, but what they carried. When we think of what crossed ancient bridges, people and animals come to mind. They did indeed pass to and from the city, but these structures carried an equally important commodity, water. Aqueducts were an incredible feat of engineering and design. The water flowing into Rome was carried thirty seven miles atop multi-tiered structures. The water was carried on the top tier in cement- lined channels. Some structures had as many as three tiers of arches. The lower tiers were often dry stacked, and no mortar used at all in their construction. These bridges are truly masterpieces that have survived seasonal floods for hundreds of years. Many appear unchanged after all these years.

In addition to building bridges and aqueducts on a huge scale over hundreds of miles, the Romans were building large cities with large public buildings and coliseums. Their roads were paved with stone and many exist today. The Romans could not accomplish this masterful work without a strong government and a system to successfully carry out projects. They developed the idea of public works, similar in some ways to our modern government departments. The head of the hierarchy established by the Romans would have been the emperor; the second tier was the government officials. Below these were the engineers, surveyors, masons, and carpenters. At the foundation of the pyramid would have been thousands of skilled laborers and slaves. Slavery has disappeared from our Public Works Department in Santa Fe, but the concept of working within a large, highly organized group has not. All departments must inform each other of their progress and intentions of one another.

A great deal of progress was made between the time that people used the random fallen log over a stream to make a safe crossing and the completion of arched stone bridges that rarely washed away. But the technology used to create these arched bridges was quite different from the techniques used in some parts of the world. In jungle areas we can speculate that people made crossings over rivers and ravines by grabbing hold nearby vines to swing over. This use of naturally occurring vines for rope eventually turned into the use of rope to create suspension bridges. Some suspension methods involve one rope to crawl across hand over hand. Two ropes can be used, one a bit higher than the other. The bottom rope is used to walk on, the upper one to hang on to. A more sophisticated method uses four ropes, two lower, two above. People walked on a deck

suspended from the top two ropes. In many parts of the world this was, and still is a practical way to span wide gaps.

About the same time Roman teams of surveyors and engineers were laying out the foundations for great new projects, teams of Incan workers high in the Andes were successfully spanning large chasms with rope strands made from the dried flower stalks of mountain grass. Tossing a light line across the gap to be spanned, successively larger ropes could be then pulled across. Eventually a twisted cable 8 inches thick would be pulled across, then a second one would be placed beside the first. Two large rocks were used as anchors on both sides of the chasm. From the anchor the cable ran over the tops of log or stone posts, and on over to the other side. A deck could then be hung or suspended from the two large cables and hand rails could be attached to the suspenders. The entire project might take less than a month to complete, looking much like a gigantic woven structure when completed.

The Incas had a very strong social system in place to allow the progress of a suspension bridge building project to move forward. Their public works were made by citizens who worked off the tax they owed to the government. Slaves were also a labor force vital to the work at hand.

Bridge Dynamics

Three basic bridge designs have been developed over the centuries in countries all over the globe; beam, arch, and suspension. There are many examples of these types around the world, and many bridges are really combinations of these basic forms.

Beam bridges consist of a horizontal girder that is supported on either end. In the case of the tree that lies with either end resting on opposing banks of a stream the tree is the beam, the banks are called abutments. When two or more logs were placed end to end and supported mid stream by a stone or upright posts, these supports are called piers. The weight of the beam pushing straight down onto the piers or abutments is called dead load, the weight of the bridge itself. By adding traffic on top of the beam, people and cars, live load is created. In either situation a dead load or live load, some bending of the bridge takes place. As the bending takes place the top edge, the deck, is being compressed. The under side is in tension, stretched. The abutments and piers are compressed by the downward force of the bridges weights. Different varieties of wood have different strengths, called tensile strength. Some bend more than others, others hold up more weight.

Wood has been used extensively in the making of bridges. Often it has been readily available, the material of choice. After the development of trusses, using the strength of triangles to brace bridge parts, bridges became longer and taller. With the development of metals, combinations of wood and iron became popular combinations of building materials. The further development of iron into steel led to the creation of bridges made entirely without wood. The superior strength of steel has lead to incredibly large spans that wood, no matter what species, is not capable of doing.

Arches are another bridge type which originally employed the use of one other building material, stone. Stone is extremely strong and can be compressed, a characteristic that makes it ideal for arches. The arch directs the downward weight along the curve of the arch into the abutments or piers. Abutments must be

substantially larger and heavier than the arch itself. This is necessary because a great deal of pressure is exerted on them by the weight of the arch itself. Force is exerted by the weight of the arch pushing outward towards the abutments. The squeezing of the stone along the arch itself is extremely intense, lots of compression and very little tension. All this compression is what makes the arch work. With such strength in the abutments and across the span, taller bridges could be built, wood had its limitations. The massive foundations also meant that taller structures could be built.

Suspension bridges use long ropes, cables, or chains to support the deck that carries people and traffic. Most modern suspension bridge cables are anchored deep in the rock on either side of the area to be spanned. A great deal of concrete is used to secure the cable ends. The cables are typically run over the tops of two sets of towers constructed away from the shore or canyon walls. The greatest length of the span is in between the towers. The horizontal deck of the bridge is held up by suspender cables, also called hangers. The hangers holding the weight of the deck are being pulled downward, stretching the cables, putting them in tension. The towers carry the weight of the entire deck. The weight pushes directly down at the top of the structure, putting the tower in compression, as if it were being squeezed. The cables are stretched into tension as the weight of the deck on the hangers pulls everything downward. Because the force pulling on the cables is so great, anchors must be massive so that they will not be ripped out of the ground. For this reason the anchors are usually embedded in foundations with very solid footing, using massive amounts of concrete.

Objectives

This curriculum unit hopes to familiarize students with the variety of bridges that exist throughout their community and the world. Through the study of nearby bridges, students will be able to recognize basic bridge designs and appreciate the variety of professional skills needed to create these structures. The completion of numerous prints, paintings, and a bridge model will familiarize students with the variety of techniques and materials available to them. They will gain knowledge of the history of bridges and become familiar with a numerous building techniques used by ancient and modern cultures. In-class interaction with members of the City of Santa Fe's bridge building design team will help students to fully understand the complexities involved with the creation of bridges.

Students will gain valuable experience as they take on the role of architect, consultant, engineer, and artist as they complete their own group project. The collaboration needed to choose a style, design, and materials for the bridge will be integrated into the learning process. Ultimately the students will gain a sense of pride in accomplishing all the tasks put forth in the group project guidelines. Individual and group responsibility will be lessons which all students will be involved. Additionally in the course of their studies students will be able to complete the following projects:

Watercolor paintings. Create a simple set of drawings during field studies of bridges near the school site. Complete a finished watercolor painting based on the initial drawings.

Linoleum block prints. Produce linoleum block prints, using pencil drawings of bridges created during field studies. Use a variety of paper and colors to create a numbered series.

Sheet rock prints. Craft a set of prints using three quarter inch sheetrock squares. Prep and carve a gypsum

board square into a workable printing plate.

Collographs. Construct collograph plates based on local bridge images. Complete a series of prints which emphasize the use of texture.

Bridge Building Design Team. Students will assume the role of a design team member. The team will be responsible for the design, creation, and presentation of a bridge model.

Strategies

As an introduction to the course students will be shown a short Power Point presentation on the history of bridges, accompanied by a narration which describes three basic bridge types; beam, arch, and suspension. Through a variety of bridge images students will be introduced to the vast numbers of bridges that have existed in the past. They will also be given a glimpse of the incredible number of bridges that exist in the world today. Following the presentation students will take a walking tour to four bridges near the school grounds. Two of the bridges are steel pedestrian bridges which are part of a paved walking path through the community. Both of these walkways have been placed within view of the school grounds. The other two are less than a quarter mile away. These two bridges are box culverts which allow the neighborhood traffic to cross through two separate channels of one larger arroyo. Both culverts carry sidewalks on either side of the paved roadway. Ornamental steel hand rails have been placed on either side of these roadway bridges. The sheet metal designs seen on the handrail are representations of indigenous animals. The railings and art work have a brown patina, similar in color to the earth tones found in the immediate area.

Students will be encouraged to carry out a set of simple pencil drawings of the roadway bridges. These sketches will be the spring line from which several other projects will rise. The bridge sketches will initially be the focus of a watercolor painting which will be carried out in the classroom, using the finished drawings as reference. In these drawings color theory and the use contrasting values will be emphasized. Additionally they will be directed to write a short story about the bridge they have just sketched.

Sketches will also be used to complete a series of drawings in a variety of mediums. The students will craft a series of prints using three printmaking techniques. These techniques will include the carving of linoleum blocks with a focus on safety and craftsmanship. The use of sheet rock squares allows students a chance to explore a printing process which will give a great deal of texture and variety to their prints. Assembling card stock collograph plates will allow students to focus on form and design layout. The hands on activities are meant to help students improve motor skills and increase manual dexterity, but more importantly it allows them flexibility in the creation of new works. Encouraging students to work in multiple styles of printmaking will help them look at the bridge designing project from a variety of perspectives.

An important component to the unit will be the discussion of the metal ornamentation installed on the hand railing of the roadway bridges. Students will be asked to consider why the bridges were placed in their particular settings. Who did the artwork that was placed there? What process did the artist go through to reach the final design? Who actually built the structures once all designs were finalized and approved? Did the community members have any input in the planning process? Did people respond positively to the completed work? Was there any adverse reaction to the work after it was installed? Looking carefully at existing works

will help students explore ideas of their own for the upcoming bridge project.

In an effort to find some answers to these questions it was necessary to contact the City of Santa Fe. After a few calls to the Public Works branch of the City of Santa Fe contact was established with the Arts Commission. It was here that a meeting was set up with the departments' consultant. The consultant gave a brief history of the arroyo crossings history. The culverts were placed in the arroyos as a result of years of spring and summer time flooding. The roadway, an unpaved dirt road, passed through the normally dry arroyo bed. Seasonal flooding would leave deep deposits of sand and mud across the road way. Often sharp cut banks occurred leaving the road bed two or three feet higher than the bottom of the newly formed wash. Damaged or stuck cars were not uncommon during those rainy or muddy times of year. The cities' Road Works department sent inspectors to make the initial determination that the road was indeed in need of paving and a set of box culverts should be put in place. This was a traditional way of dealing with the crossing, one that has proved successful in other areas with similar situations. The process helped determine which projects were eligible to use funding for public art work. The two crossing sites and a roundabout traffic circle nearby all qualified for the same funding.

At this point a design team was brought together. This team included the Arts Commission consultant, a Road Works engineer, an architect, and a pre qualified artist. The team researched the project, developed a plan, sought approval for the project, and implemented the plan. It was this group that brought the developed plans to the city council for approval. As a group they meet with representatives from the communities directly affected by the construction and placement of the culverts. It was through this forum that the artist established criteria for a workable plan for the handrails, one acceptable to the public. Through their continued efforts the project was completed successfully, on time, and under budget. All projects have recently been completed. As the public art here has not been formally dedicated it is possible that students and their bridge projects could become a part of a larger community dedication with all appropriate parties present, including representatives from the mayor's office.

Forming a design team was a crucial part of this bridge building project. The design team made it possible for the creation of new public art in the community. Santa Fe is a city which puts great value on art work in all its many forms. Students will learn much from the team concept as they form a design team of their own in the classroom. They will be asked to form a team that closely approximates the Public Works model. Prior to the completion of their own bridge project students will be able to meet with members of the city team. During this classroom visit students will be able to talk directly with the members of the city team and ask them questions about the challenges encountered as the project moved forward. There are numerous examples of public art located around the city. The consultant to the Arts Commission will be able to explain her role making those pieces appear and the importance of art in the community. The architect and the engineer will speak to the issues of material use on the projects and decisions about location form, and structural requirements. The artist will be able to explain the design process and answer questions about the conversation between the team and the public as designs were developed.

Bridge projects completed by each student design team will be presented in display cases located in the school lobby. Parents, visitors, and the entire student body will all be able to share in the achievements of the bridge builders.

An additional artist, whose work is somewhat more controversial, will be asked to come into the classroom. This artist works with spray paint and markers to create graffiti. Sometimes called urban art, often called vandalism, the form is ever present in our culture and it continues to gain popularity among today's youth.

The art form shows up in the big city and small towns all across the nation. It is fixed deeply in hip hop culture. It shows up on the bridges near the school. Many make the argument that graffiti is made to represent artistic ideas, other forms are made to represent gang affiliation. Fashion designers and advertisers have raised the form to new heights of acceptance. Video game makers have come out with heroes tagging buildings. Museums around the country display exhibits of graffiti murals. Filmmakers produce movies and documentaries on the subject. Artists like Keith Herring have moved their work from illegal locations to more legitimate venues, often into retail spaces.

Students are quite familiar with the form and it mysteriously appears nightly throughout the city. It shows up on the bridges near the school. Students often comment on graffiti art, many express the desire to create work in graffiti style. The bridge project will become an important vehicle to open a dialogue about the issues surrounding the creation of graffiti art as its presence remains prevalent in our lives.

A visit by the artist will help students become more aware of the implications of creating art on other peoples' property. The artist is familiar with the fines and jail time given to taggers who get caught in the middle of creating their most recent piece of illegal art. Additionally the students will see how some graffiti artists channel their desire to create new art forms on less controversial surfaces.

Creating a Power Point presentation of their experiences with visiting artists and city employees is a wonderful way for students to become involved in their community. They will see how important it is for members of a community to work together towards a common goal. There are many possibilities for screening the finished production piece. Community dinners or open houses at the school, collaborative work with other classes, or end of year presentations and portfolio reviews. All these venues are an excellent way for students show off an interest and pride in themselves and their community.

Classroom Activities

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1. Water color paintings.

Students will create a series of water color paintings. The water colors will be based on observations and field sketches. Natural objects and local bridges will be the subject matter. These drawings and paintings will form the core of a larger set of works, prints made through several different printing processes. Sketching the bridges on site will allow the students to develop their own perspective of a specific scene, and further their ability to carry out life drawings. Drawing from life can lead to an improved ability to draw what they imagine. Many architects and designers use water color as a medium to begin studies for bridge and building designs. One of the more famous modern designers is Santiago Calatrava. Students can become aware of his work via the internet prior to painting. He is well known for his water color renderings of natural forms, people, and animals. His artistic interest in drawing and painting form the basis for the architectural designs that he goes on to develop. The students' bridge sketches will be the focus of a watercolor painting which will be carried out in the classroom, using the finished drawings as reference.

Objectives:

Students will learn how to create a water color using the plein air technique, painting on location, from real life. Students will recognize the difference in paper weights and texture. Students will draw parallels between

drawing natural forms and creating designs for three dimensional projects. Students will strengthen their ability to draw what they see as opposed to drawing from their imagination.

Procedure:

If drawing boards are not available, spiral note books or cardboard can be used for the drawing surface. Give each student a piece of water color paper 8 ½ x 11, or smaller. Size of the paper is dictated by the size of the drawing surface. Give each student a few inches of masking tape to lay down the paper. Carrying their boards and sharpened #2 pencils students will proceed to the predetermined drawing site. Pan water color sets with #4 and #6 brushes can be carried in a bucket, along with water containers and water. Upon arrival at the site students should be instructed to find a location with the view they wish to develop into a painting. Once situated students can begin to sit and draw, keeping in mind what they ultimately want to achieve, a finished painting. Have them lightly sketch in contours of the bridge and its surroundings, trees, mountains, houses, banks of the arroyo, bushes, and grasses. Shading and shadows do not need to be addressed yet. Once a fairly complete representation of the scene has been rendered, the watercolor sets can be passed out and used to add large areas of color. Students can experiment by painting in areas with clear water, then adding pigment which has been loaded onto the brush from the water color pan. This wet on wet method will be good for putting in general background or large areas of color. After the wet areas have been allowed to dry a little, dry on dry methods can be used to put drier, more controllable portions of paint in detailed areas of the scene. As paintings are built up in this manner the students can use darker values to create darker values and contrast.

Materials: water color paper, brushes, masking, tape, #2 pencils

2. Sheet Rock Prints.

Students will create prints using a printing plate made from gypsum board, a material commonly found in lumber companies or home repair stores. Students will learn techniques involved with the preparation and carving of the board. Using paintings and sketches from previous classes as inspiration, students will be able to experiment with the varied surface quality of the gypsum board. Emphasis will be placed on creating simple images which take advantage of the grainy, coarse nature of the gypsum board. Students will use many elements of design as the work through the printing process, particular importance will be their use of color, line, shape, and texture.

Objectives:

Students will identify different printmaking styles. Students will use a variety of techniques to create prints. Students will be able to draw parallels between very old technologies used in printmaking, and modern application of new material.

Procedure:

Students will create their printing plates out of a 5"x 7"piece of sheetrock. Working on a piece of newspaper, the first step in the process is to dampen the light brown backing paper on the rectangle of sheetrock. A small sponge, cut out of a larger sponge, can be used for this purpose. The surface must be damp, but not soaked, so that the paper on the back can be peeled off completely. Peeling is usually a tedious process so enough time needs to be given to carry out the task. Once the backing is gone the pieces should be labeled on the opposite side with a marker for easy identification. The printing design can be placed on a piece of copy

paper. Lines of the design should be darkened with a number #2 pencil. A reverse image can easily be placed on the sheetrock side of the plate by rubbing on the back side of the paper, making a faint line appear on the plate surface. The surface can then be carved using a large nail or spike. Students should be advised not to carve too deeply, only a quarter inch or so. The decision has to be made as to which areas will be inked and which will be carved, defining the positive and negative spaces in the design. Once carving is finished the inking surface can be sealed with polyvinyl acetate (PVA). Sealing eliminates the possibility of loose gypsum particles interfering with the quality of the prints as they are pulled from the plate. Additionally, using PVA as a seal keeps printing ink from soaking into the plate, rather that sitting on the surface where it will come in contact with the printing paper. All that remains is the application of ink to the dried plate and careful placement of paper over the plate. The plate is now ready to be placed in the printing press. Students should be reminded to keep their hands clean as they begin to handle the paper for the finished print. Making decisions about paper size and color should be made prior to inking the plates. Finished prints should be set in a drying rack, labeled by class. If mounting mattes are not available, simple oversize paper can be used for displaying the works. The prints can be placed on a piece of paper that is approximately 1" larger than the painting itself and glued down.

Materials: Sheetrock, 18p nails, sponge pieces, polyvinyl acetate (PVA), brushes, printing ink, printing paper

3. Bridge Building Design Team

Student bridge building teams will research, design, and construct a small bridge model in class. By using the City of Santa Fe's model for the project students will gain knowledge of group dynamics as they analyze the various professions involved in the creation of a bridge. Each team will be given a different set of conditions under which their group is to build the bridge. Different physical challenges, traffic conditions, housing needs, community concerns, and issues of access by the public will be considered as the team moves forward with their shared ideas and plans. The team will be given an opportunity to meet with members of a bridge design team from the City of Santa Fe. Students will be able to ask the team members about the challenges and rewards of their chosen professions here in Santa Fe.

Objectives:

Students will identify and use skills involved in the professional fields of architecture, engineering construction, art, and city planning. Students will be able to recognize basic bridge structures and become familiar with the historical development of these bridge types.

Procedures:

Students will be put into groups of 5 or 6. Each group will follow the model of the City of Santa Fe bridge design teams. Each student in the group will assume the role of a design team member. These roles consist of the architect, engineer, contractor, artist, and consultant. Some roles may need to be shared, depending on the size of the group. Two days will be set aside for students to research the roles they assume. Students will specifically look for information on what the educational requirements of each profession are, what kinds of skills are needed to perform their duties, and what knowledge of the art world is necessary to carry out the task of bridge building. Each member will report back to the group, sharing their knowledge of what their field of expertise entails.

Each group will then research which type of bridge would best suit the particular site and the criteria to be used. Once the bridge type is selected the group will have a discussion of what materials would be needed to

make a model of the bridge. The group will then present their findings to the class before moving to the building phase of the project. Next, a scale drawing of the bridge should be made. Individual pieces of the bridge can be measured directly from the plan. Each group will be given a 36"x 12" piece of composition board which will form a platform for the bridge. Materials provided to the students to begin the construction of the project are listed in the next sub-section. Other materials can be brought in to supplement the list. The structures will be limited to 18" in height.

Materials:

Paper, #2 pencils, 18"x1/4"x1/4" aspen sticks, electric drills, small cutoff saws, brads, glue, string, paperclips, tape, acrylic paint, clay, small dowels, flat craft sticks, foam core strips

Implementing District Standards

New Mexico Educational Standards

Visual Arts Standard 1: Learn and develop the essential skills and technical demands unique to dance, music, theatre/drama, and visual arts. Grade 5-8 students will:

A. Explore art materials, techniques, qualities, characteristics, and processes; understand what makes them effective in solving specific art problems and how they are used to enhance life experiences and ideas.

1. Engage in problem-solving activities that apply the principles of art to the elements of art.

Creating paintings and sketches using the different methods suggested in this curriculum will engage students in problem solving. They will use a variety of techniques as they explore application of materials needed to carry out the project.

Visual Arts Standard 4: Demonstrate an understanding of the dynamics of the creative process. Grade 5-8 students will:

A. Explore the influence of personal experiences, imagination, and the dynamics of culture to works of art.

> 1. Create art in which design elements and principles in conjunction with subject, themes and content are based on personal experiences to create meanings.

B. Understand how the qualities and characteristics of various art, media, techniques, and processes influence the creative process to communicate experiences and ideas.

1. Discuss specific instances in which culture influences art.
2. Identify and describe the emotional connotations of the use and placement of design principles and elements in a particular piece of art.
3. Describe orally or in written form a personal reaction to at least three pieces of art in different media.
4. Demonstrate how the use of traditional and different media can convey meanings, (softness of pastels and watercolors, texture of collage, sparseness of wire, etc).

Watercolor painting, drawing, and printmaking lend themselves to the presentation of personal experiences and the use of design elements created by the student. During this project students will be asked to use their own imagery and designs has the produce a series of paintings, drawings, and prints. Students will carry out writings in the form of short stories and classroom critiques. The writings done in class will demonstrate personal reactions to the works created during the unit activities.

Visual Art Standard 7: Demonstrate knowledge about how technology and invention have historically influenced artists and offered new possibilities for expression.

Grade 5-8 students will:

A. Use, review, and evaluate computers and other electronic media as tools for design and communication of ideas.

1. Identify the appropriate type of technology use to achieve a desired outcome. Demonstrate how all student participation can be enhanced through technology.
2. Incorporate the use of a least one means of technology in creating an original work of art.

Computers can be used in a variety of ways to meet these standards. Power Point presentations can be made by students and presented in class. Internet sites can be accessed, research carried out, and reports made with the use of computers. Bridge models can be created before the construction begins.

Teacher Resource

Brown, Davic J., *Bridges: Three Thousand Years of Defying Nature,* Firefly Books Ltd, 2002

This is a wonderful book for showing the origins of bridges, development of materials through history, excellent pictures.

Dupre, Judith, *Bridges*, Black Dog & Leventhal Publishers, New York: Dover, 2003

Lots of great photographs in this book and a great discussion about bridge design.

Goldstein, Barbara, *Public Art by the Book,* University of Washington Press, 2005

This book has a very good explanation of the design team process often adopted by cities in the process of creating spaces with public art.

Gottemoeller, Fredrick, *Bridgescape: The Art of Designing Bridges*, New York: John Wiley & Sons, 2004

More technical in its scope, this book discusses the engineering of a bridge.

Graf, Bernard, *Bridges that Changed the world, Prestel, 2002*

This book addresses the issues of bridges within communities, what happens when a bridge is built. Good set of pictures.

Jacob, David and Neville, Anthony E., *Bridges, Canals, and Tunnels: The Engineering Conquest of America,* American Heritage

Publishing Co., Inc., 2002

While this book tends to cover only the industrial rise of the United States, it gives one a good sense of the advances in technology in the short lifetime of America.

Johmann, Carol A. and Rieth, J, Bridges!: *Amazing Structures to Design, Build, and Test,* Williamson, Charlotte, VT, 1999

This book gives an explanation of forces involved in the construction of arches, beams and suspension bridges. Tension and compression are thoroughly discussed. There are some useful classroom activities in throughout the book.

McCullough, David, *The Great Bridge:The Epic Story of the Building of the Brooklyn Bridge*, Simon and Schuster, 1972

This book has a great overall picture of the creation of an iconic bridge. McCullough's books are always school friendly.

Tzonis, Alexander, *Santiago Calatrava: The Poetics of Movement*, New York: Universe Publishing, 1999

Wonderful water colors shown in this book form the basis for many projects created by this prolific artist, sculptor, and architect. There are numerous pictures of the incredible bridges he has made at sites around the world.

Student Resources

Adkins, Jan, *From My Side to Yours*, Roaring Brook Press, 2002

This is a simple book with lots of information for young readers. The drawings illustrating various forms and techniques are rendered in a nice way.

Brown, David J., *Bridges: Three Thousand Year of Defying Nature*, Firefly Books Ltd, 2002

This book is an excellent classroom resource for students to browse. The photographs give a wonderful overview of bridges from ancient times to today's modern structures.

Dupre, Judith, *Bridges*, Black Dog & Leventhal Publishers, New York 1997

Great photographs abound in this book. The pictures form a wonderful array of bridges around the country. Interesting format used to present images of the bridge.

Johmann, Carol A. and Rieth, J, Bridges!: *Amazing Structures to Design, Build, and Test,* Williamson, Charlotte, VT, 1999

This book gives an explanation of forces involved in the construction of arches, beams and suspension bridges. Tension and compression are thoroughly discussed. There are some useful classroom activities in throughout the book. It is written at an elementary school level, but its simple explanation of forces and bridge types transfer well into the middle school classroom.

Tzonis, Alexander and Donadei, Rebeca, *Santiago Calatrava: The Bridges*, New York: Universal Publishing, 2005

Letting students look at the variety of bridges that Calatrava has created is definitely of value. They can gain inspiration from the transition from organic shapes to finished bridge. Students can begin to see how far people have come with bridge design since the ancient Romans. Calatrava's work is modern in the extreme, but full of wonderful natural shapes and forms.

McCullough, David, *TheGreat Bridge: The Epic Story of the Building of the Brooklyn Bridge, Simon and Schuster,* 1972

This book is very student friendly. It gives a narrative that is easily followed by students. The illustrations present great representations of the bridges, the drawings themselves are wonderful to look at on their own.