

**Subject Area:**

Engineering, Mathematics, Biology, Archaeology, Geography

**Title:**

Build a Bridge . . . and Get Over it!

**Teacher:****School:****Lesson Objective(s) & Career Cluster:**

This unit will incorporate principles of mathematics, engineering, archaeology, biology, architecture, cooperative learning, and problem-solving. Working in teams, students will take the roles of different team members needed to solve the problem (and possibly even make it more complicated).

These team members include:

Civil Engineer/Architect  
Water Specialist  
Environmental Activist/Biologist  
Archaeologist/Native American Representative

**Activity:**

The first goal of the team will be to decide if it is possible to replace the bridge in its current location or build a new bridge. Each person will try to put themselves in the place of their assigned role. In other words, the engineer needs to remember that their primary objective is to build a bridge and cooperate with all other parties involved. The other members may have interests and agendas to protect the things that are important to them; i.e. the environmentalist will mainly be concerned with protecting the area's natural resources from the construction of the bridge. In the end, the goal of a new bridge will be built, but the process is important to understand the complexity of such an undertaking.

First, each member will do some research in their area of expertise before meeting as a team. The following are a few research questions and ideas for each person:

**Civil Engineer:** What is a Civil Engineer and how does one become one?  
What specifically is a bridge engineer?

Using one of the maps provided and the data from the bridge itself, predict where you think the new bridge would go and how you would design it to avoid the potentially flooded area.

**Water Specialist:** Where is Caddo Lake and why is it a unique lake?

Research the tributaries that connect to Caddo Lake and list at least three. Using

the following website, research the significance of the Little Cypress Bayou:

1. Go to [www.tpwd.state.tx.us](http://www.tpwd.state.tx.us)
2. Search for Little Cypress Bayou
3. Click on the link "Region D-Northeast Texas" and read the description of the bayou. If necessary, contact a water specialist in your area to help you understand some of the terminology.

**Environmental Activist:** Research the significance of the Caddo Lake ecosystem and its designation as a national wildlife refuge and wetland of significance.

What is an old growth forest and why should it be protected?

Research the following state protected species and decide if the bridge project would disrupt their habitat in significant ways:

Bluehead shiner, Paddlefish, Creek chubsucker, Refinesque's big-eared bat, Alligator snapping turtle, northern scarlet snake, timber/canebrake rattlesnake, Texas trillium (plant)

Research the following federally protected species and decide if the bridge project would disrupt their habitat in significant ways:

Louisiana Black Bear, Bald Eagle, Neches River rose-mallow (plant)

<b>Archaeologist/ Native American Representative</b>	Who were the Caddo Indians? How do you know that Indians have resided in a certain location? What is the procedure when a Caddo Indian habitation is found before or during a bridge construction project? How long can a bridge project or any other construction project be delayed when archaeologically significant areas are found in the right of way or adjacent properties?
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### **Evaluation:**

Evaluation: The teams must agree to disagree, but have to know that a bridge will be built. Using PowerPoint or another presentation system, each group will decide where the bridge will be built and what obstacles they had to overcome to make their decision. The group must come to a consensus on the location and design of the bridge as well. The presentation will be graded as well as each group evaluated for how well they worked together to reach a solution. The following rubric may be used:

60 or below	No consensus reached, no bridge built, research and presentation inadequate
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70-79	Consensus reached with some arguments, tentative construction plans, presentation lacking in many areas
80-89	Firm consensus reached, construction plans decided, presentation lacking in a few areas
90-100	Firm consensus reached, all members researched thoroughly and prepared, construction plans firm and detailed, thorough and balanced presentation

**Extension/Modification and/or Instructional Methodology:**

Extensions: Have the students use a basic CAD program, Google Earth, and/or ArcView (if available) to draw a detailed plan of the bridge. This may take a phone call or visit from a local civil engineer to help with some of the program basics. A free program such as Google SketchUp may be used if CAD software is not available. The students may also use pencil, ruler, and grid paper to make a paper sketch if computers are not available or as a preliminary drawing before developing the digital plans.

**SCAN Skills:**

**Basic Skills:**

Reads, writes, performs arithmetic and mathematical operations, listens and speaks

- A. Reading—locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules
- B. Writing—communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts
- C. Arithmetic/Mathematics—performs basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques
- D. Listening—receives, attends to, interprets, and responds to verbal messages and other cues
- E. Speaking—organizes ideas and communicates orally

**Thinking Skills:**

Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn, and reasons

- A. Creative Thinking—generates new ideas
- B. Decision Making—specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative
- C. Problem Solving—recognizes problems and devises and implements plan of action
- D. Seeing Things in the Mind's Eye—organizes, and processes symbols, pictures, graphs, objects, and other information
- E. Knowing How to Learn—uses efficient learning techniques to acquire and apply new knowledge and skills
- F. Reasoning—discovers a rule or principle underlying the relationship between two or objects and applies it when solving a problem

**Personal Qualities:**

Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

- A. Responsibility—exerts a high level of effort and perseveres towards goal attainment
- C. Sociability—demonstrates understanding, friendliness, adaptability, empathy, and
- D. Self-Management—assesses self accurately, sets personal goals, monitors progress, and exhibits self-control
- E. Integrity/Honesty—chooses ethical courses of action

**Five Workplace Competencies:****Resources:**

Identifies, organizes, plans, and allocates resources

- A. *Time*—Selects goal-relevant activities, ranks them, allocates time, and prepares and follows schedules
- B. *Money*—Uses or prepares budgets, makes forecasts, keeps records, and makes adjustments to meet objectives
- C. *Material and Facilities*—Acquires, stores, allocates, and uses materials or space efficiently

**Interpersonal:**

Works with others

- A. *Participates as Member of a Team*—contributes to group effort
- B. *Teaches Others New Skills*
- D. *Exercises Leadership*—communicates ideas to justify position, persuades and convinces others, responsibly challenges existing procedures and policies
- E. *Negotiates*—works toward agreements involving exchange of resources, resolves divergent interests
- F. *Works with Diversity*—works well with men and women from diverse backgrounds

**Information:**

Acquires and uses information

- A. *Acquires and Evaluates Information*
- B. *Organizes and Maintains Information*
- C. *Interprets and Communicates Information*
- D. *Uses Computers to Process Information*

**Systems:**

Understands complex inter-relationships

- B. *Understands Systems*—knows how social, organizational, and technological systems work and operates effectively with them

**Technology:**

Works with a variety of technologies

- A. *Selects Technology*—chooses procedures, tools or equipment including computers and related technologies
- B. *Applies Technology to Task*—Understands overall intent and proper procedures for setup and operation of equipment

## **Cooperative Learning Ideas, TAAS, TEKS Competencies:**

### TAKS Objectives:

#### **Architectural Graphics (One-Half to One Credit).**

(c) Knowledge and skills.

(1) The student applies architectural graphics technology to practical problems. The student is expected to:

- (A) apply architectural graphics technology to individual and community problems;
- (B) describe the factors that affect the use of architectural graphics products and services; and
- (C) identify and describe the roles of architectural graphics in business and industry.

(2) The student uses the appropriate architectural graphic design processes and techniques to develop a variety of architectural drawings. The student is expected to:

- (A) develop or improve architectural drawings that conform to industry standards; and
- (B) identify areas where the quality and reliability of communication can be improved using architectural graphics technology.

(8) The student manages an architectural graphics technology project. The student is expected to:

- (A) develop a plan for completing an architectural graphics technology project;
- (B) participate in the organization and operation of a real or simulated architectural graphics project; and
- (C) determine the resources needed to complete a project.

(10) The student solves problems, thinks critically, and makes decisions related to architectural graphics. The student is expected to:

- (A) develop or improve a product by following a problem-solving strategy;
- (B) apply critical-thinking strategies to the analysis and evaluation of proposed technological solutions; and
- (C) apply decision-making techniques to the selection of

technological solutions.

(11) The student describes the factors that influence the cost of producing architectural graphics drawings. The student is expected to:

- (A) develop a budget for architectural graphics project; and
- (B) determine the most effective strategies to minimize costs.

(12) The student applies his/her communication, mathematics, and science knowledge and skills to architectural graphics activities. The student is expected to:

- (A) use written, verbal, and visual communication techniques consistent with industry standards;
- (B) use mathematics concepts in architectural graphics technology;
- (C) identify and apply science principles used in architectural graphics technology; and
- (D) use the appropriate scales for measuring.

(13) The student describes the importance of teamwork, leadership, integrity, honesty, work habits, and organizational skills. The student is expected to:

- (A) describe how teams function;
- (B) use teamwork to solve problems;
- (C) distinguish between the roles of team leaders and team members;
- (H) complete his/her work according to established criteria.

### **Engineering Graphics (One-Half to One Credit).**

(c) Knowledge and skills.

(1) The student applies engineering graphics technology to practical problems. The student is expected to:

- (A) apply engineering graphics technology to communicate ideas;
- (B) describe the factors that affect the use of engineering graphics items;
- (C) identify and describe the roles of engineering graphics; and
- (D) use engineering graphics to help visualize objects and conduct

analyses.

(2) The student designs an item using appropriate engineering graphic design processes and techniques. The student is expected to:

(A) develop or improve an item using engineering graphics technology; and

(B) use traditional and concurrent engineering design processes.

(3) The student investigates emerging and innovative engineering graphic technologies. The student is expected to:

(A) report on emerging and innovative engineering graphic technologies; and

(B) describe the advantages and disadvantages of changes in engineering graphics technology.

(4) The student describes the importance of quality and how it is determined in engineering graphics. The student is expected to:

(A) describe different quality control applications in engineering graphics; and

(B) apply continuous quality improvement techniques to the design of an item.

(5) The student produces a variety of engineering drawings using the appropriate tools, equipment, machines, materials, and processes. The student is expected to:

(A) describe the tools, equipment, machines, materials, and processes used in engineering graphics; and

(B) use a variety of engineering graphics tools, equipment, and machines (traditional and computer-based) to produce drawings or models.

(8) The student manages an engineering graphics technology project. The student is expected to:

(A) participate in the organization and operation of a real or simulated engineering graphics project;

(B) develop a plan for completing an engineering graphics project; and

(C) determine the resources needed to complete a project.

(10) The student solves problems, thinks critically, and makes decisions

related to engineering graphics. The student is expected to:

- (A) develop or improve a product by following an engineering design problem-solving process;
- (B) apply critical-thinking strategies to the analysis and evaluation of proposed technological solutions;
- (C) apply decision-making techniques to the selection of technological solutions; and
- (D) evaluate proposed solutions to problems.

(11) The student describes the factors that influence the cost of producing engineering graphic drawings. The student is expected to:

- (A) develop a budget for an engineering graphics project; and
- (B) determine the most effective strategies to minimize costs.

(12) The student applies his/her communication, mathematics, and science knowledge and skills to engineering graphics activities. The student is expected to:

- (A) use written, verbal, and visual communication techniques consistent with industry standards;
- (B) use mathematics concepts when producing drawings;
- (C) identify and apply science principles used in engineering graphics; and
- (D) use the appropriate scales for measuring.

(13) The student describes the importance of teamwork, leadership, integrity, honesty, work habits, and organizational skills. The student is expected to:

- (A) describe how teams function;
- (B) use teamwork to solve problems;
- (C) distinguish between the roles of team leaders and team members;
- (D) identify characteristics of good leaders;
- (E) identify employers' expectations and appropriate work habits;
- (F) define discrimination, harassment, and equality;

(G) use time management techniques to develop and maintain work schedules and meet deadlines; and

(H) complete his/her work according to established criteria.

**Team Project, Guest Speaker, or Field Trip:**

Team Project: Discussed in Objective Section

Field Trips: There are two possibilities for field trips and a third option. The first of course is to go and actually visit the bridge so that the students can get a first-hand look at the variables, elevation, etc. The second is to walk or transport the class to a nearby bridge site and discuss bridge building. It may not be possible to do that as well, so the third option is to have a bridge engineer from TXDOT come to the classroom to discuss what it takes to build a bridge. Any of these would be a worthwhile extension to the bridge-building unit.

**Resources:**

Digital Imagery of Bridge Location and Pictures of Bridge and Bridge Area  
Internet Research  
Google Earth (optional)  
Google Sketchup (optional)  
CAD Software (optional)

Additional Resources:

*(Included with lesson plan)*

Cypress basin—map of Cypress Basin Watershed  
bridgeareapicdescriptions.htm—links to pictures of bridge area  
bridgepics.html—pictures of the bridge structure itself  
Maps:  
Harrison County Bridge Full View (Word File)  
bridgecloseup.jpg  
bridgezoom1.jpg, bridgezoom2.jpg, bridgezoom3.jpg  
fm450(zoom).jpg  
M450.jpg