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| **TEXAS CTE LESSON PLAN**  [www.txcte.org](http://www.txcte.org) | |
| **Lesson Identification and TEKS Addressed** | |
| **Career Cluster** | Science, Technology, Engineering and Mathematics |
| **Course Name** | Engineering Mathematics |
| **Lesson/Unit Title** | Concepts of Engineering: Math |
| **TEKS Student Expectations** | **130.413. (C) Knowledge and Skills**  (4) The student uses mathematical concepts of structure design to define and describe statics, acquire data, apply concepts of moments and bending stress, and apply concepts of truss design and analysis  (A) The student is expected to calculate a resultant force  (B) The student is expected to apply the concept of equilibrium to force calculations  (C) The student is expected to calculate a force using a free-body diagram  (6) The student understands the concepts of design processes with multi-view computer-aided drafting and design drawings for facilities layouts, precision part design, process design, injection mold design, and computer-aided manufacturing, as applied to processes using 3D printing, laser cutting, and computer numerical control  (A) The student is expected to determine a dimension of an object given a scaled drawing having no dimensions |
| **Basic Direct Teach Lesson**  (Includes Special Education Modifications/Accommodations and  one English Language Proficiency Standards (ELPS) Strategy) | |
| **Instructional Objectives** | Students will be able to   * understand and apply the team building process * learn the difference between a truss and suspension bridge * understand and apply dimensional analysis and the principles of design * understand the importance of technical drawings * construct a truss or suspension bridge, using the principles of design |
| **Rationale** | At the end of this lesson, the students will understand the essential engineering mathematical concepts that will allow them to practice civil engineering design principles by scaling, measuring and constructing a model truss or suspension bridge. |
| **Duration of Lesson** | Ten 45-minute class periods |
| **Word Wall/Key Vocabulary**  *(ELPS c1a,c,f; c2b; c3a,b,d; c4c; c5b) PDAS II(5)* | **Team Building**: a workplace design in which employees are encouraged to workinterdependently and cooperatively as team members, rather than as individual workers  **Dimensional Analysis**: the study of the physical dimensions and measurements of an object  **Principles of Design**: also called elements of design, and which consist of balance, emphasis,movement, pattern, repetition, proportion, rhythm, variety, and unity  **Technical Drawing:** a general term for an image that shows a realistic portrayal of a place oran object; technical drawings can show the building instructions for an object, the operation of an object, or a drawn-to-scale layout of a location  **Truss Bridge**: a bridge composed of trusses, which are made of triangular shaped segmentsmade of pins and joints  **Suspension Bridge**: a bridge which is supported by suspension cables from which the deck orroadway is hung |
| **Materials/Specialized Equipment Needed** | **Instructional Aids:**   * Bridge Model Making Data Sheet for each design team   **Materials Needed:**   * Engineering Notebook * Pen and Pencil * Picture of truss or suspension bridge * Graph Paper * Tape Measure * Scissors * Scotch Tape * Glue * Measuring tools: compass, ruler * Bridge Model Making Data Sheet   **Equipment Needed:**   * Computer * Projector |
| **Anticipatory Set**  (May include pre-assessment for prior knowledge) | **SAY:** Today we are going to learn about the principles of design as we design a truss orsuspension bridge model.  **ASK:** Does anyone know of any well-known designs? (have class share ideas)  **ASK:** Can anyone think of anything that might be of importance to consider when designingyour bridge? (let class discuss)  **SHOW:** Videos with examples of designs, focusing on Balance, Emphasis, Movement,Pattern, Repetition, Proportion, Rhythm, Variety, and Unity  **SAY:** Now that you know a few key things to consider, you may begin designing your truss orsuspension bridge model.  **SHOW:** Once students have finished their bridges, allow them to measure the dimensions andtest them for resultant force. Verify the Principles of Design used in each bridge design and compare the model to its technical drawing.  **SAY:** This bridge illustrates the best Principles of Design (Balance, Emphasis, Movement,Pattern, Repetition, Proportion, Rhythm, Variety, and Unity). |
| **Direct Instruction \*** | Instructors can use photos, handouts, and note pages in conjunction with the following outline:  I. Principles of Design  A. Schedule of Assignments  B. Introduction/Course Description  C. Objectives and Results  D. Vocabulary  E. O\*Net [(www.onetonline.org](http://www.onetonline.org/))  II. Principles of Design  A. Lesson sections  B. Team Building  III. Principles of Design   1. Dimensional Analysis   IV. Principles of Design   1. Discuss the 9 Principles of Design   V. Principles of Design   1. Technical Drawings   VI. Principles of Design   1. Bridge Contest   *Individualized Education Plan (IEP) for all special education students must be followed. Examples of accommodations may include, but are not limited to:*  None |
| **Guided Practice \*** | After class measurements of bridges and discussion, the teacher will explain why winning bridge won.  *Individualized Education Plan (IEP) for all special education students must be followed. Examples of accommodations may include, but are not limited to:*  None |
| **Independent Practice/Laboratory Experience/Differentiated Activities \*** | Have student teams evaluate everyone's bridge and explain what they would change on their own for next time.  *Individualized Education Plan (IEP) for all special education students must be followed. Examples of accommodations may include, but are not limited to:*  None |
| **Lesson Closure** | **Question:** What is the approximate length of your bridge?  **Answer:** Answers will vary.  **Question:** What is the approximate width of your bridge?  **Answer:** Again, answers will vary.  **Question:** What is approximate weight of your bridge?  **Answer:** Again, answers will vary.  **Question:** Does your bridge design match your technical drawing design?  **Answer:** Again, answers will vary.  **Question:** What design principles did you apply to your bridge design?  **Answer:** Again, answers will vary.  **Question:** What would you do differently if you made another bridge?  **Answer:** Could be any of the following or others: lighter weight, new materials, better balance,etc. |
| **Summative/End of Lesson Assessment \*** | **Informal Assessment**   * The teacher will observe the students as they construct their bridges. Look for teamwork, use of the principles of design, and unique designs.   **Formal Assessment**   * Create a team of three students and research truss and suspension bridges. In this team building exercise, students will visit the school’s library and research truss and suspension bridges. * Develop a plan for designing your team’s truss or suspension bridges. * Create a technical drawing of your team’s bridge. * Construct your team’s bridge. * Complete your team’s bridge and create a presentation. * Present your team’s presentation and test the strength of your team’s bridge. |
| **References/Resources/**  **Teacher Preparation** | Katzenbach, Jon R., and Smith, Douglas K., The wisdom of teams: creating the high-performance organization; Jon R. Katzenbach, Douglas K. Smith Harvard Business School Press, Boston, Mass.: 1993  Units: The Metric System  <http://www.unc.edu/~rowlett/units/metric.html>  Metric System vs. Customary System  <http://www.michigan.gov/mda/0,1607,7-125-2961_2971-8927--,00.html>  Balance video; from YouTube user; uxpassion;  <http://www.youtube.com/watch?v=WZQpbVG0gYU>  Emphasis video; from YouTube user; Ari Richter;  [http://www.youtube.com/watch?v=\_qoqtnSF7io;](http://www.youtube.com/watch?v=_qoqtnSF7io)  Movement video; from YouTube user; expertvillage;  <http://www.youtube.com/watch?v=w-o4bmICWNU>  Pattern video; from YouTube user; expertvillage;  <http://www.youtube.com/watch?v=Dv0gHvgn9OY>  Repetition video; from YouTube user; expertvillage;  <http://www.youtube.com/watch?v=ZfSnAkRF27c>  Proportion video; from YouTube user; expertvillage;  <http://www.youtube.com/watch?v=S4dp6EcDuTM>  Rhythm video; from YouTube user; expertvillage;  <http://www.youtube.com/watch?v=vwxvryBppTo>  Variety video; from YouTube user; expertvillage;  <http://www.youtube.com/watch?v=i7nuBLr8xgo>  Unity video; from YouTube user; expertvillage;  <http://www.youtube.com/watch?v=WIednL9ZgF0> |
| **Additional Required Components** | |
| **English Language Proficiency Standards (ELPS) Strategies** |  |
| **College and Career Readiness Connection[[1]](#footnote-1)** |  |
| **Recommended Strategies** | |
| **Reading Strategies** |  |
| **Quotes** |  |
| **Multimedia/Visual Strategy**  **Presentation Slides + One Additional Technology Connection** |  |
| **Graphic Organizers/Handout** |  |
| **Writing Strategies**  **Journal Entries + 1 Additional Writing Strategy** |  |
| **Communication**  **90 Second Speech Topics** |  |
| **Other Essential Lesson Components** | |
| **Enrichment Activity**  (e.g., homework assignment) | Students should construct a modeled truss or suspension bridge that uses different materials. |
| **Family/Community Connection** |  |
| **CTSO connection(s)** | SkillsUSA  Technology Student Association (TSA) |
| **Service Learning Projects** |  |
| **Lesson Notes** |  |

1. Visit the Texas College and Career Readiness Standards at <http://www.thecb.state.tx.us/collegereadiness/CRS.pdf>, Texas Higher Education Coordinating Board (THECB), 2009. [↑](#footnote-ref-1)