Unit 2: Essential Infrastructure Designs: Transportation Systems

Content Area: **Technology**
Course(s): **Engineering**
Time Period: **Week 6**
Length: **5 Weeks**
Status: **Published**

Unit Overview

In this unit, the class will explore the transportation systems that we use everyday from an engineering perspective.

Students will work collaboratively within a simulated/virtual world to recreate a transportation system that conquers geographical challenges and includes a roadway system with bridges and tunnels, along with a railroad system.

Standards

TECH.8.1.5	Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
TECH.8.1.5.A	Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.
TECH.8.1.5.A.1	Select and use the appropriate digital tools and resources to accomplish a variety of tasks including solving problems.
TECH.8.1.5.A.CS1	Understand and use technology systems
TECH.8.1.5.A.CS2	Select and use applications effectively and productively.
TECH.8.1.5.B	Creativity and Innovation: Students demonstrate creative thinking, construct knowledge and develop innovative products and process using technology.
TECH.8.1.5.B.CS1	Apply existing knowledge to generate new ideas, products, or processes.
TECH.8.1.5.B.CS2	Create original works as a means of personal or group expression.
TECH.8.1.5.C	Communication and Collaboration: Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others.
TECH.8.1.5.C.CS1	Interact, collaborate, and publish with peers, experts, or others by employing a variety of digital environments and media
TECH.8.1.5.C.CS4	Contribute to project teams to produce original works or solve problems
TECH.8.1.5.D	Digital Citizenship: Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior.
TECH.8.1.5.D.3	Demonstrate an understanding of the need to practice cyber safety, cyber security, and cyber ethics when using technologies and social media.
TECH.8.1.5.D.CS1	Advocate and practice safe, legal, and responsible use of information and technology.
TECH.8.1.5.E	Research and Information Fluency: Students apply digital tools to gather, evaluate, and use information.

TECH.8.1.5.E.CS1	Plan strategies to guide inquiry.
TECH.8.1.5.F	Critical thinking, problem solving, and decision making: Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources.
TECH.8.1.5.F.CS1	Identify and define authentic problems and significant questions for investigation.
TECH.8.1.5.F.CS2	Plan and manage activities to develop a solution or complete a project.
TECH.8.1.5.F.CS3	Collect and analyze data to identify solutions and/or make informed decisions.
TECH.8.1.5.F.CS4	Use multiple processes and diverse perspectives to explore alternative solutions
TECH.8.2.5	Technology Education, Engineering, Design, and Computational Thinking - Programming: All students will develop an understanding of the nature and impact of technology, engineering, technological design, computational thinking and the designed world as they relate to the individual, global society, and the environment.
TECH.8.2.5.A	The Nature of Technology: Creativity and Innovation: Technology systems impact every aspect of the world in which we live.
TECH.8.2.5.A.2	Investigate and present factors that influence the development and function of a product and a system.
TECH.8.2.5.A.CS1	The characteristics and scope of technology.
TECH.8.2.5.A.CS2	The core concepts of technology.
TECH.8.2.5.C	Design: The design process is a systematic approach to solving problems.
TECH.8.2.5.C.1	Collaborate with peers to illustrate components of a designed system.
TECH.8.2.5.C.4	Collaborate and brainstorm with peers to solve a problem evaluating all solutions to provide the best results with supporting sketches or models.
TECH.8.2.5.C.5	Explain the functions of a system and subsystems.
TECH.8.2.5.C.7	Work with peers to redesign an existing product for a different purpose.
TECH.8.2.5.C.CS1	The attributes of design.
TECH.8.2.5.C.CS2	The application of engineering design.
TECH.8.2.5.C.CS3	The role of troubleshooting, research and development, invention and innovation and experimentation in problem solving.
TECH.8.2.5.D	Abilities for a Technological World: The designed world is the product of a design process that provides the means to convert resources into products and systems.
TECH.8.2.5.D.1	Identify and collect information about a problem that can be solved by technology, generate ideas to solve the problem, and identify constraints and trade-offs to be considered.
TECH.8.2.5.D.2	Evaluate and test alternative solutions to a problem using the constraints and trade-offs identified in the design process to evaluate potential solutions.
TECH.8.2.5.D.4	Explain why human-designed systems, products, and environments need to be constantly monitored, maintained, and improved.
TECH.8.2.5.D.5	Describe how resources such as material, energy, information, time, tools, people and capital are used in products or systems.
TECH.8.2.5.D.7	Explain the impact that resources such as energy and materials used in a process to produce products or system have on the environment.
TECH.8.2.5.D.CS1	Apply the design process.

Essential Questions

- Why is a transportation system integral to the economic well-being of a community?
- What design elements enable a bridge to support great weight?
- How are tunnels made under waterways?

Application of Knowledge: Students will know that...

- A well run city needs an effective transportation system for its citizenry
- Bridges come in different sizes and shapes to solve the engineering challenges that arise when connecting two land points
- t took engineers thousands of years to perfect the art of digging tunnels

Application of Skills: Students will be able to...

- Build roads, bridges, and tunnels for a transportation system for their city in a simulated/virtual world
- Define: compression, tension, immersed-tube tunnel, tunnel lining, railroad siding, railroad turnout

Assessments

- City of the Future Design Rubric and Scoresheet
- Student Presentations
- Information from this unit will be included on a locally developed, end of course benchmark assessment that may take the form of a test, performance based project, or other summative assessment.

Suggested Activities

Watch excerpts from: PBS: Building Big Series on DVD - Bridges

How does a bridge withstand the forces of nature and traffic? Host David Macaulay takes viewers from the stone arch bridges of the Roman Empire to Japan's giant, all-steel Akashi Kaikyo suspension bridge, the longest in the world. Through the epic sagas of the Brooklyn, Golden Gate, and other great bridges, Macaulay shows how engineers have conquered ever-wider spans with better construction materials and innovative designs.

Watch excerpts from: PBS: Building Big Series on DVD - Tunnels

How do tunnels stay dry under water? Who dug the first tunnels? Go underground with award-winning author-illustrator--and captivating storyteller--David Macaulay (The Way Things Work) and get an amazing look at tunnels, from ancient Rome to the remarkable Channel Tunnel that connects France and England, through

spectacular film footage, little-known facts, and dramatic recreations.

The Bridge Challenge

Objective: Students will test their knowledge about bridges by pairing the correct bridge design with the needs of the community.

http://www.pbs.org/wgbh/buildingbig/bridge/challenge/index.html

Brainpop Video: Bridges

Objective: Students will learn about how bridges are designed and built, the distances they can span, and the physical principles behind them. They will find out the differences between the three main types of bridges--beam bridges, arch bridges, and suspension bridges. Students will learn how engineers add special supports called trusses to make bridges stronger and how the forces of gravity, tension, and compression act on all bridges.

https://www.brainpop.com/technology/scienceandindustry/bridges/

Y-Chart Brainpop Activity

Objective: List facts about the three basic bridge types mentioned in the video. Give advantages and disadvantages of each design.

https://www.brainpop.com/technology/scienceandindustry/bridges/activity/#=graphicOrganizer

Build a model suspension bridge

Objective: Students will make a model suspension bridge with straws, tape, dental floss, and paper clips.

http://www.pbs.org/wgbh/buildingbig/educator/act_suspension_ho.html

Research Report: Research a bridge in your state

Objective: Students will select a bridge in either NJ or NY and report on what type of bridge it is, date of completion, obstacle it crosses, longest span and three fun facts about the bridge.

https://www.brainpop.com/technology/scienceandindustry/bridges/activity/

The Tunnel Challenge

Objective: Students will learn that tunnel diggers have used different types of tools and techniques to carve through mountains. They will have the opportunity to choose a geographic location, pick a tunnel-digging technique, and see how long it takes to dig a mile-long tunnel.

http://www.pbs.org/wgbh/buildingbig/tunnel/challenge/index.html

Forces Lab

Objective: Forces act on structures in many ways. Students will investigate these forces at work and see real life examples.

http://www.pbs.org/wgbh/buildingbig/lab/forces.html

Activities to Differentiate Instruction

Differentiation for special education:

- General modifications may include:
    - Modifications & accommodations as listed in the student's IEP
    - Assign a peer to help keep student on task
    - Modified or reduced assignments
    - Reduce length of assignment for different mode of delivery
    - Increase one-to-one time
    - Prioritize tasks
    - Think in concrete terms and provide hands-on-tasks
    - Position student near helping peer or have quick access to teacher
    - Anticipate where needs will be

    - Content specific modifications may include:

        - Provide written instructions and Minecraft building guidelines
        - Students will benefit from established routines and seating, and peer-to-peer teamwork that encourage a cooperative learning environment
        - Students who have completed the current project can investigate online Minecraft tutorials for additional creative solutions
        - Students may work at their own pace
        - Reduce/increase assignment requirements

Differentiation for ELL's:

- General modifications may include:
    - Strategy groups
    - Teacher conferences
    - Graphic organizers
    - Modification plan
    - Collaboration with ELL Teacher

- Content specific vocabulary important for ELL students to understand include: span, pier, gravity, tension, compression, buckle, displace, bridge

Differentiation to extend learning for gifted students:

- Students with an advanced Minecraft skillset may conduct additional Internet research to acquire new mining skills and building techniques.
- Activities to encourage additional exploration of engineering concepts:
    - Select a famous bridge or tunnel and study its engineering design and re-create it in your virtual city.

Integrated/Cross-Disciplinary Instruction

Social Studies - Explore real life bridges (Akashi Kaikyo, Brooklyn, Golden Gate, Firth of Forth) and tunnels (Chunnel, Chesapeake Bay, Holland) and create models of transportation infrastructure systems.

Math - practice ratio and proportion; geometry and measurement associated with building and design

Science - find out how forces affect structures like tunnels and bridges

Engineering - Design and build a model of an arch bridge, suspension bridge, railroad system, and underwater tunnel

Resources

- DVD - *David Macaulay: Building Big Tunnels, PBS*
- DVD - *David Macaulay: Building Big Bridges, PBS*
- DVD - *Everyday Engineering: Understanding the Marvels of Daily Life*, Professor Stephen Ressler, The Great Courses
- Course Guidebook - *Everyday Engineering: Understanding the Marvels of Daily Life*, Professor Stephen Ressler, The Great Courses
- *The Spotter's Guide to Urban Engineering: Infrastructure and Technology in the Modern Landscape*, Claire Barratt & Ian Whitelaw, 2011
- http://www.pbs.org/wgbh/buildingbig/
- http://www.pbs.org/wgbh/buildingbig/bridge/challenge/index.html
- https://www.brainpop.com/technology/scienceandindustry/bridges/
- http://www.pbs.org/wgbh/buildingbig/educator/act_suspension_ho.html
- https://www.brainpop.com/technology/scienceandindustry/bridges/activity/
- https://www.brainpop.com/technology/scienceandindustry/bridges/activity/#=graphicOrganizer
- http://www.pbs.org/wgbh/buildingbig/tunnel/challenge/index.html

- http://www.pbs.org/wgbh/buildingbig/lab/forces.html

21st Century Skills

CRP.K-12.CRP1.1	Career-ready individuals understand the obligations and responsibilities of being a member of a community, and they demonstrate this understanding every day through their interactions with others. They are conscientious of the impacts of their decisions on others and the environment around them. They think about the near-term and long-term consequences of their actions and seek to act in ways that contribute to the betterment of their teams, families, community and workplace. They are reliable and consistent in going beyond the minimum expectation and in participating in activities that serve the greater good.
CRP.K-12.CRP2.1	Career-ready individuals readily access and use the knowledge and skills acquired through experience and education to be more productive. They make connections between abstract concepts with real-world applications, and they make correct insights about when it is appropriate to apply the use of an academic skill in a workplace situation.
CRP.K-12.CRP4.1	Career-ready individuals communicate thoughts, ideas, and action plans with clarity, whether using written, verbal, and/or visual methods. They communicate in the workplace with clarity and purpose to make maximum use of their own and others' time. They are excellent writers; they master conventions, word choice, and organization, and use effective tone and presentation skills to articulate ideas. They are skilled at interacting with others; they are active listeners and speak clearly and with purpose. Career-ready individuals think about the audience for their communication and prepare accordingly to ensure the desired outcome.
CRP.K-12.CRP5.1	Career-ready individuals understand the interrelated nature of their actions and regularly make decisions that positively impact and/or mitigate negative impact on other people, organization, and the environment. They are aware of and utilize new technologies, understandings, procedures, materials, and regulations affecting the nature of their work as it relates to the impact on the social condition, the environment and the profitability of the organization.
CRP.K-12.CRP6.1	Career-ready individuals regularly think of ideas that solve problems in new and different ways, and they contribute those ideas in a useful and productive manner to improve their organization. They can consider unconventional ideas and suggestions as solutions to issues, tasks or problems, and they discern which ideas and suggestions will add greatest value. They seek new methods, practices, and ideas from a variety of sources and seek to apply those ideas to their own workplace. They take action on their ideas and understand how to bring innovation to an organization.
CRP.K-12.CRP7.1	Career-ready individuals are discerning in accepting and using new information to make decisions, change practices or inform strategies. They use reliable research process to search for new information. They evaluate the validity of sources when considering the use and adoption of external information or practices in their workplace situation.
CRP.K-12.CRP8.1	Career-ready individuals readily recognize problems in the workplace, understand the nature of the problem, and devise effective plans to solve the problem. They are aware of problems when they occur and take action quickly to address the problem; they thoughtfully investigate the root cause of the problem prior to introducing solutions. They carefully consider the options to solve the problem. Once a solution is agreed upon, they follow through to ensure the problem is solved, whether through their own actions or the actions of others.
CRP.K-12.CRP11.1	Career-ready individuals take personal ownership of their own education and career goals,

and they regularly act on a plan to attain these goals. They understand their own career interests, preferences, goals, and requirements. They have perspective regarding the pathways available to them and the time, effort, experience and other requirements to pursue each, including a path of entrepreneurship. They recognize the value of each step in the education and experiential process, and they recognize that nearly all career paths require ongoing education and experience. They seek counselors, mentors, and other experts to assist in the planning and execution of career and personal goals.