Project Planning Template

CAREER CLUSTER: Architecture & Construction	DURATION: Approximately 20 sessions, but can be modified to fit classroom schedules. (Session = 45 to 50 Minutes)	TEACHER:	U.N. SUSTAINABLE DEVELOPMENT GOAL: #9 — Industry, Innovation, and Infrastructure

GLOBAL ISSUE OVERVIEW

As the world's population is expected to grow to nearly 9.6 billion people by the year 2050, sustainable development in industry will be crucial to meet economic and social demands. According to the United Nations, "Industrialization's job multiplication effect has a positive impact on society. Every one job in manufacturing creates 2.2 jobs in other sectors." Growth in productivity and income can lead to improvements in quality of life as well as a reduction of inequalities. Addressing the challenge of changing global economic realities and reducing inequality will require further industrialization underpinned by innovation and resilient infrastructure.

Additionally, many people around the world lack access to basic infrastructure such as roads, sanitation, and electrical power. The United Nations states that "2.3 billion people worldwide lack access to basic sanitation and almost 800 million lack access to water." Heavy investments in infrastructure are needed to promote economic growth and social balance. Meeting this challenge will require innovative approaches that aim to reduce environmental impact. Increases in industrialization must not come at the cost of Earth's natural resources which are already stressed and will be in even higher demand as the population rises.

Why should I care?

Growth of new industries typically results in an improved standard of living. Yet, too often, industrialization and environmental protection have been at odds with one another. The fate of the planet and the human race require a more symbiotic relationship. Any plan that seeks to eliminate poverty will require investments in infrastructure and a commitment to inclusive industrialization. Likewise, to sustain such a large population, we must do all that we can to protect our natural resources and fight climate change. As the world grows, and the planet warms, old ways of development will need to change. With already scarce resources and a dwindling freshwater supply, any improvements to infrastructure must not come at the cost of the environment.

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Global Competencies Addressed:

- *Investigate the World*: Initiate investigations of the world by framing questions, analyzing and synthesizing relevant evidence, and drawing reasonable conclusions about global issues.
- *Recognize Perspectives*: Recognize, articulate, and apply an understanding of different perspectives.
- *Communicate Ideas*: Select and apply appropriate tools and strategies to communicate and collaborate effectively — meeting the needs and expectations of diverse individuals and groups.
- *Take Action*: Translate ideas, concerns, and findings into appropriate and responsible individual or collaborative actions to improve conditions.

STANDARDS ADDRESSED		
Career/Technical Knowledge and Skills	**Academic Knowledge and Skills**	**21st Century Skills**
Common Career Technical Core **Career Ready Practices** 1. Act as a responsible and contributing citizen and employee. 4. Communicate clearly and effectively and with reason. 5. Consider the environmental, social, and economic impacts of decisions. 6. Demonstrate creativity and innovation. 7. Employ valid and reliable research strategies. 8. Utilize critical thinking to make sense of problems and persevere in solving them. 9. Model integrity, ethical leadership, and effective management. 12. Work productively in teams while using cultural global competence. **Architecture & Construction Career Cluster** 2. Use architecture and construction skills to create and manage a project.	**Next Generation Science Standards** Engineering Design: • **HS-ETS1-1.** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. • **HS-ETS1-2.** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. • **HS-ETS1-3.** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. • **HS-ETS1-4.** Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within	**Learning & Innovation Skills** • Creativity & Innovation • Critical Thinking & Problem Solving • Communication • Collaboration

• **AC 2.2:** Estimate resources/materials required for a specific project or problem. • **AC 2.3:** Use available resources/materials effectively while completing a project or resolving a problem with a project plan. • **AC 2.4:** Determine alternative solutions for a specific project/problem. 3. Comply with regulations and applicable codes to establish and manage a legal and safe workplace/jobsite. • **AC 3.2:** Identify workplace/jobsite environmental hazards of a given situation. • **AC 3.3:** Identify governmental regulations and national, state, and/or local building codes that apply to a given workplace/jobsite.	and between systems relevant to the problem. **Common Core Academic Standards** ELA/Literacy: • **RST.11-12.7.** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. • **RST.11-12.8.** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. • **RST.11-12.9.** Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.	

PROJECT DEFINITION & GOALS/OBJECTIVES

This project stems from the United Nation's Sustainable Development Goals (SDGs) initiative. The SDGs are a set of 17 goals that aim to end poverty, fight inequality, and stop climate change. Specifically, this project focuses on Global Goal #9: Industries, Infrastructure, and Innovation. Students will engage in a design process and brainstorm solutions that improve infrastructure, promote industrialization, and spur innovation while reducing environmental impact through the conservation of water. Students will create, test, and improve upon infrastructure prototypes meeting specific criteria to support SDG #9. They will then use these prototypes to communicate their ideas with an authentic audience while demonstrating an understanding of architecture and construction skills within the context of SDG #9.

Goals

- Students will understand how geography, climate, and natural resources of a region influence the industry, infrastructure, innovations, and lifestyle of the people living there.
- Students will use architecture and construction skills and knowledge to design a pipeline or aqueduct system that demonstrates innovation, improves infrastructure, and reduces environmental impact.
- Students will understand how pipelines and aqueduct systems are developed and their impact on the environment.
- Students will design a sustainable construction proposal to bring fresh water to their local community.

Objectives

- Research global, national, and local water scarcity issues.
- Research global, national, and local green infrastructure innovations.
- Identify current green architecture and construction strategies.
- Create innovative prototypes of pipeline or aqueduct systems.
- Write a detailed management plan for the construction of their pipeline or aqueduct system that estimates materials, determines alternative solutions, identifies environmental hazards, describes environmental impact, and complies with national, state, and/or local building codes.
- Present prototypes and sustainable construction proposal to local community.

SCENARIO OR PROBLEM: What scenario or problem will you use to engage students in this project?

Local industry is placing undue stress on the water supply, and access to fresh water has become an issue in your town, which is now considering building a pipeline or aqueduct system to bring fresh water to the community. You need to look at other pipeline projects such as the Trans Africa Pipeline Project and California's extensive water supply system. Consider the pros and cons of pipeline solutions and ascertain if it is an option for your community — where is the nearest freshwater source? How could a pipeline or aqueduct system be constructed? Based on your findings, design a sustainable construction proposal to alleviate shortages of water in your community.

Essential Questions	Grade Level Adaptations
• To what extent does infrastructure promote innovation and support industry? • In what ways can green design solutions be used to improve infrastructure and reduce water scarcity? • How do environmental concerns influence decisions in architecture and construction? • What opportunity costs exist in green construction?	**Elementary Adaption —** Introduce elementary aged students to the idea of water conservation and why it is important. Share multiple strategies about how you can conserve water personally as well as how engineers design structures to better save water and/or reduce water contamination. Share and discuss current practices such as rain barrels, rain gardens, green roofs, etc. Then challenge students to design a playground that saves water. Have students build playground models/prototypes to communicate their ideas.

	• Design scenario: Your school will be remodeling their playground. The architects have asked you to develop a playground that conserves water. The playground must be safe, visually appealing, and fun as well as conserve water, reduce runoff, and harvest rainwater. **Middle School Adaptation —** Introduce students to water pipelines as a means to mitigate water scarcity. Research current water pipelines such as the Trans Africa Pipeline. Discuss the purpose, challenges, and trade-offs of these pipelines. Challenge students to design a pipeline from paper towel rolls that can transport a golf ball (i.e., water) across the classroom. Set up protected ecosystems that the students must avoid. • Design scenario: Your engineering team must design a pipeline system that transports water (i.e., a golf ball) from one end of the classroom to the other. Your design must incorporate at least three angles and one must be 90 degrees. You must avoid all environmentally protected areas in the classroom. Your design may not finish more than 20 inches below the height of the starting position of the pipeline.

ASSESSMENT: How will you determine what students have learned? (Check all that apply.)			
FORMATIVE		**SUMMATIVE**	
Quizzes/Tests		Multiple Choice/Short Answer Test	
Notes/Graphic Representations		Essay Test	
Rough Draft	**X**	Written Product with Rubric	**X**
Practice Presentation	**X**	Oral Presentation with Rubric	**X**
Preliminary Plans/Goals/Checklists of Progress	**X**	Other Product or Performance with Rubric	
Journal/Learning Log		Self-Evaluation or Reflection	
Other:		Evaluation by Authentic Audience	**X**
		3D model	**X**
		Other:	

MATERIALS, RESOURCES, or CONSTRAINTS: What materials and resources will be needed? Are there any perceived challenges?

Resources:

- World Wildlife Fund: Water Scarcity
- U.N. Sustainable Development Goals
    - Goal 9: Build Resilient Infrastructure, Promote Sustainable Industrialization, and Foster Innovation (includes links to the U.N. Development Programme, the U.N. Children's Fund, the International Monetary Fund, and more)
- Zoe Schlanger's article, "We Can't Engineer Our way out of an Impending Water Scarcity Epidemic" (a perspective on water scarcity and innovations necessary to avoid a major water shortage crisis from *Quartz Magazine*)
- Erica Gies' article, "Sponge cities can limit urban floods and droughts" from *Scientific American*
- "Freshwater Crisis: Looming Shortages" from *Scientific American*
- Arjen Y. Hoekstra's article, "Water Scarcity Challenges to Business" from *Scientific American*
- Water Scarcity and the Private Sector — Introduction to a Special Report (a collection of articles and resources on the impact of water shortage from *Scientific American*)
- David Biello's article, "Eco-cities: Urban Planning for the Future" from *Scientific American*
- Trans Africa Pipeline Project
- California Water Supply Infrastructure
- Video resources:
    - TEDEd's video, "Are we Running out of Clean Water?" (5:10) This video comes with lesson and discussion resources.
    - TED's playlist, "TED Talks on Water" This playlist consists of a variety of videos about water.
    - TEDEd's video, "Urbanization and the Future of Cities" (4:09) This video comes with lesson and discussion resources.

- United Nations Foundation's video, "A Look at the Sustainable Development Goals" (1:00). An introduction to the 17 Sustainable Development Goals from the United Nations Foundation.
- TED's video, "7 principles for building better cities" A TED Talk by Peter Calthrope that is about building sustainable cities.

SUPPORT, MODIFICATIONS, AND EXTENSIONS: What is needed to provide support for students who have difficulty learning the content, modify for students with special learning needs, or to provide enrichment for advanced students?

Some students might struggle with reading and researching to gain understanding of the concepts addressed by SDG #9. Consider holding small group discussion sessions based on articles or videos shared in class. You might consider doing a "Jigsaw" reading activity with the entire class. Assign each group a different article to read or video to watch. Each group then summarizes the key points from their assigned reading or viewing and shares with the class. This reduces the volume of research and, not only saves time, but supports struggling readers who might find it difficult to keep up or comprehend large amounts of content in a shortened timeframe.

CALENDAR OF MAJOR LEARNING ACTIVITIES: What are the learning activities or tasks for each day? Are there any project milestones? When will formal assessment activities occur?

Week 1				
Monday	Tuesday	Wednesday	Thursday	Friday
Initiating: Lead lesson and discussion focused on building awareness and context for SDG #9.	**Initiating:** Expand on and deepen prior lesson on SDG #9 focusing on the essential questions: • To what extent does infrastructure promote innovation and support industry? • In what ways can natural design solutions be used to	**Initiating:** Students generate questions and challenge assumptions. Facilitate a discussion and record questions for continued research.	**Planning:** Form teams of four to five students. Present the project scenario/problem. Push students to continue their research and identify the criteria and constraints they must consider in their project. Guide students with the following questions: • What are the environmental impacts of pipeline and aqueduct systems? • What examples of green	**Planning:** Form teams of four to five students. Present the project scenario/problem. Push students to continue their research and identify the criteria and constraints they must consider in their project. Guide students with the following questions: • What are the environmental impacts of pipeline and aqueduct systems? • What examples of green

	improve infrastructure and reduce water scarcity? • How do environmental concerns influence decisions in architecture and construction? • What opportunity costs exist in green construction?		pipelines/aqueducts already exist? • What are the trade-offs of green technology? • What national, state, or local codes must be considered?	pipelines/aqueducts already exist? • What are the trade-offs of green technology? • What national, state, or local codes must be considered?
Week 2				
Planning: Armed with research, data, and information, student teams brainstorm possible solutions. Facilitate the brainstorming session(s) and encourages all ideas. Encourage multiple possibilities and allow the brainstorming to drive further research.	**Planning:** Students determine their best solution while keeping environmental and economic realities of their community in mind. Students generate a plan to address their solution and assign team roles and responsibilities by breaking the project down into smaller, more manageable parts. *Formative Assessment Opportunity: Require students to submit a preliminary plan or checklist outlining the steps they will*	**Executing:** Facilitate work time for the teams. Students should be working to create their pipeline/aqueduct prototype, draft their management plan, and create their presentations.	**Executing:** Facilitate work time for the teams. Students should be working to create their pipeline/aqueduct prototype, draft their management plan, and create their presentations.	**Executing:** Facilitate work time for the teams. Students should be working to create their pipeline/aqueduct prototype, draft their management plan, and create their presentations.

	take to complete their project.			
Week 3				
Executing: Facilitate work time for the teams. Students should be working to create their pipeline/aqueduct prototype, draft their management plan, and create their presentations.	**Executing:** Facilitate work time for the teams. Students should be working to create their pipeline/aqueduct prototype, draft their management plan, and create their presentations.	**Executing:** Facilitate work time for the teams. Students should be working to create their pipeline/aqueduct prototype, draft their management plan, and create their presentations.	**Executing:** Students complete first iteration of their prototype as well as their management plan and share it with the class and/or teacher. Students explain the purpose and key features of their design, gather feedback and/or run tests, identify failure points, or areas of improvement and make revisions. *Formative Assessment Opportunity: Students present first iteration of their prototype with first draft of management plan.*	**Executing:** Students complete first iteration of their prototype as well as their management plan and share it with the class and/or teacher. Students explain the purpose and key features of their design, gather feedback and/or run tests, identify failure points, or areas of improvement and make revisions. *Formative Assessment Opportunity: Students present first iteration of their prototype with first draft of management plan.*
Week 4				
Executing: Students complete first iteration of their prototype as well as their management plan and share it with the class and/or teacher. Students explain the purpose and key features of their design, gather feedback and/or run tests, identify failure	**Executing:** Students complete first iteration of their prototype as well as their management plan and share it with the class and/or teacher. Students explain the purpose and key features of their design, gather feedback and/or run tests, identify failure	**Closing:** Students present their solutions to an authentic audience —local officials, politicians, architects, urban planners, etc. Students could also post solutions (pictures, brief	**Closing:** Students present their solutions to an authentic audience —local officials, politicians, architects, urban planners, etc. Students could also post solutions (pictures, brief summaries, etc.) to social media such as Twitter,	**Closing:** Students present their solutions to an authentic audience —local officials, politicians, architects, urban planners, etc. Students could also post solutions (pictures, brief summaries, etc.) to social media such as Twitter,

points, or areas of improvement and make revisions. *Formative Assessment Opportunity: Students present first iteration of their prototype with first draft of management plan.*	points, or areas of improvement and make revisions. *Formative Assessment Opportunity: Students present first iteration of their prototype with first draft of management plan.*	summaries, etc.) to social media such as Twitter, Instagram, or Facebook using the hashtag #Goal9. *Summative Assessment: 3D model, final management plan, oral presentation to authentic audience.*	Instagram, or Facebook using the hashtag #Goal9. *Summative Assessment: 3D model, final management plan, oral presentation to authentic audience.*	Instagram, or Facebook using the hashtag #Goal9. *Summative Assessment: 3D model, final management plan, oral presentation to authentic audience.*

STUDENT REFLECTION ACTIVITIES: How will students reflect on their work? Add reflection questions and/or activities here.

The following are reflection activities you might choose to incorporate throughout the unit:

- Provide a prompt at the end of each session and have students write their reflections in a journal.
- Using a site like Flipgrid, allow students to post video reflections of their work and development.
- Guide summary activities at the end of research days such as:
    - Two Dollar Summary: Students write summaries of what they learned, but each word is worth ten cents.
    - Gallery Walk: Students write or draw what they learned on large sheets of paper then walk through the gallery reading each other's charts.
- Allow students to create a blog that details the problem they are trying to solve and the process they are engaged in for solving it.

Adapted from:

- "Sustainable Development Goals: Goal 9: Build Resilient Infrastructure, Promote Industrialization, and Foster Innovation," 2018, New York: The United Nations. Retrieved from https://www.un.org/sustainabledevelopment/infrastructure-industrialization/
- "Unit Planning Template" by the Southern Regional Education Board, n.d., Atlanta: Southern Regional Education Board.