

Dream School Engineering Challenge Guidelines and Requirements

Introduction: The population on Earth continues to skyrocket, putting great stress on our environment. Today you will begin the task of planning for and creating a sustainable school in a part of the world. The task of your design team is to take into account many different socioeconomic, engineering, and environmental factors. You will work in teams to design a school that incorporates many of the elements that you will learn about throughout the week. You and your team should note that you may need to adjust your design throughout the week as you learn more about urban infrastructure. At the end of the week you will present your school to your fellow campers and parents. Campers may choose to create a physical representation or use technology to create a virtual school. They will select a school name and design marketing materials to inform the community and attract students to their school.

Concepts: Urban Infrastructure, City Planning, Earthquakes, Erosion, Landslides

Skills: Observations, predicting, problem solving, analysis of data, synthesis of data, engineering, architecture, spatial reasoning, argumentation, communication

Safety: *Although the materials in this activity are considered nonhazardous, follow all normal laboratory safety guidelines. Any food-grade items that have been brought into the lab are considered laboratory chemicals and are for lab use only. Do not taste or ingest any materials in the laboratory, and do not remove any food items from the lab after use. Wear safety glasses or chemical splash goggles whenever working with chemicals, heat, or glassware in the lab. Wash hands thoroughly with soap and water before leaving the lab. Use caution when working with scissors and other sharp objects.*

Preparation: Prior to the activity, the facilitator should gather all materials to distribute to the group. Encourage students to use available materials creatively, and to incorporate as many factors about urban infrastructure as they can throughout the week. Students will work in teams of about four.

Materials:

- World map
- USA map
- 1 or 2 sheets of large poster board
- large, shallow cardboard box (or large cardboard box cut in half to make it shallow)
- large, shallow plastic tray or container
- markers/crayons/colored pencils/paint and brushes
- construction paper
- scissors
- gluestick
- yarn/string

- fishing line
- newspaper/magazines
- adhesive tape
- duct tape
- rubber bands
- small milk cartons, cardboard boxes, or other containers (for buildings)
- aluminum foil
- plastic cling wrap (for windows in buildings)
- sand
- pebbles
- modeling clay
- wooden dowels or toothpicks
- pipe cleaners
- small pitchers of water
- rulers
- other craft supplies at the facilitator's discretion

Timeline Overview:

Day One (65 minutes total across Phases 1 and 2)

- Dream School Visioning

Day Two (85 minutes total across Phases 3 and 4)

- Designing the Dream School
 - Blueprint
 - Initial construction of model

Day Three (85 minutes total across Phases 5 and 6)

- Designing the Dream School
 - Construction of model

Day Four (100 minutes total across Phases 7 and 8)

- Designing the Dream School
 - Completion of model
 - Initial work on marketing plan

Day Five (90 minutes total across Phases 9 and 10)

- Introducing the Dream School to the Community
 - Finalize marketing plan
 - Present Dream School during STEMtastic Friday Celebration

Day One - Phase One (35 minutes)

Tell students that today we will begin the process of designing their dream school which will be placed anywhere in the world they choose. To design a school, we will spend the week learning about urban infrastructure to inform our thinking. Having an overall understanding of a larger urban infrastructure plan as well as the geologic factors that influence infrastructure design will help us learn ideas that we can incorporate into our school such as how we use the land around the school, what sustainable features the building or classrooms might have and what type of energy is used to power our school.

Divide the students into teams of about four. Allow each team to choose a city profile (pp. 30-139) from the US and Canada Green City Index (<http://tinyurl.com/kq4d22t>). Print a copy of the pages needed from the index or if possible, have students access the index online.

Give each team 15-20 minutes to read through the information about their city. Encourage teams to assign different sections of the city profile to different team members. Have each student identify one highlight from their section that stands out to them. Then have the teams decide which 1-2 idea(s) they will share with the larger group.

- CO₂
- Energy
- Land use
- Buildings
- Transport
- Water
- Waste
- Air
- Environmental Governance (if applicable)

Have teams share their findings about the most important 1-2 things they learned from their city profile. For example, a team that selects to analyze Boston may share that they really liked the Urban Wilds Initiative that protects urban green space. Capture what each group shares on the board or somewhere to which they can refer back to throughout the week.

Day One - Phase Two (30 minutes)

Show students the Green Schools website (<http://tinyurl.com/k6xc8e4>) and select one or more of the school profiles. Discuss what these schools did to “go green.”

Have each team brainstorm the big ideas that will begin the design of their school:

- What is the one big idea that will make your school special? Think of it this way, what is the one thing you could tell a news reporter that would attract her to come visit your school because it is so unique? E.g., The way we power our school through solar energy, we grow 25% of our own food in the school’s garden, or the building is designed so that every classroom has a pond ecosystem inside the room itself.

- Think about the categories you explored from the City Index. Your big idea could come in one or more of these areas:
 - CO₂
 - Energy
 - Land use
 - Buildings
 - Transport
 - Water
 - Waste
 - Air
 - Environmental Governance (if applicable)
- Where will your school be located?
- What will you name your school and why?
- What will be your school mascot and why?

Have the teams share their initial ideas for their Dream School.

Day Two - Phase Three (55 minutes)

Overview (10 minutes)

Introduce the overarching goals and requirements for this engineering challenge. Encourage the teams to think BIG as this project is their team's Dream School. They will need to defend their decisions, taking into account what they have learned or will learn the remainder of the week, but the possibilities for their Dream School are boundless.

Engineering Challenge Goals:

By the end of the week, each team will create a physical model of their Dream School and the surrounding neighborhood/school property using the supplies provided. Optional: Use available appropriate technology, such as Google Sketch Up, to create a virtual model of the school.

Each team will choose a piece of poster board, a shallow cardboard box, or a shallow plastic container to use as the base in which to build their Dream School model. If they plan to use real water in the design or testing of the school, they should use a plastic container as the school's base.

The teams will create a model of their schools and the surrounding grounds (e.g., parking lot, playground, school garden, etc.), but they can model a sample classroom as well. Depending on the number of students per group you may choose to have each team assign lead designers for the school grounds and the sample classroom (if applicable).

At the end of the week, teams will give a 5-minute presentation displaying and describing their Dream School to the rest of the group. The rest of the group will take notes during each presentation. At the end of all of the presentations, students and parents will vote on the school they would most like to attend, including feedback explaining why they chose that school.

Engineering Challenge Requirements:

Provide each team with a copy of the Dream School Engineering Challenge Planning Guide.

Getting Started:

- What is the one big idea that will make your school special?
- Where will your school be located?
- What will you name your school and why?
- What will be your school mascot and why?

Nuts and Bolts:

- What size population can the school handle? What grade levels will it serve?
- Where will students and teachers eat?
- What special features will the classrooms have?
- What additional infrastructure will you design around the school (E.g., parking lot, recess area, school garden, etc.)?
- What sort of recreational facilities will the school have?
- Will all of the classrooms have the standard 4-wall structure or will there be some common areas for learning?
- Have you considered all of the arts? Where will students practice/play/perform?
- Is your school building only for students and teachers or will it be a resource for the community, too?
- What accommodations have been made for safety and accessibility?
- What will your school look like from the outside?

Design Categories from the City Index:

- CO₂
 - Will you have any special design considerations regulations associated with your Dream School to reduce CO₂ emissions (E.g., no idling zone)?
- Energy
 - How will you provide power to your school (E.g., solar, wind)? Have you considered special design features to use natural lighting?
- Land use
 - What special features will you design using the land around the school (E.g., Community garden or recreational area, compost area)?
- Buildings
 - Are there any special considerations regarding the structure of the building you will take into account (E.g., materials used to construct the building)?
- Transport
 - How will students and staff travel to the school? Will you have any special policies like making the school community based so all students are encouraged to walk or bike to school? Is this feasible? Also, are there any special considerations when it comes to students and staff traveling throughout the school or transporting materials to the school (E.g., The school's cafeteria is

adjacent to the community garden so fresh vegetables can be easily carried to the cafeteria)?

- Water
 - Where does the water come from for your school? Will you have any special policies regarding water use (E.g., A certain percentage of water use will come from rain barrels located on the school grounds)?
- Waste
 - How will your school dispose of waste? Will you have a special recycling program at your school?
- Air
 - This can tie into CO₂ and energy considerations. Will your school need air conditioning? What about the emissions associated with transport of students and materials to the school by vehicles?

Designing for your environment:

- What measures did you put in place to mitigate erosion?
- Based on the school's location, what are the biggest concerns when it comes to natural disasters such as major storms, earthquakes, landslides, etc.?
- Based on the design of the school's infrastructure, how will the school withstand natural disasters such as major storms, earthquakes, landslides, etc.?
- Based on the school location and design, what are the biggest concerns when it comes to the environment (e.g. runoff, pollution, etc.)?

Blueprint (20-30 minutes)

Before materials are distributed to the teams, they must first design a sketch of what their school and surrounding neighborhood/school property looks like. Distribute several Discovery Education STEM Camp lab sheets to each team and a ruler.

Tell the teams to revisit their brainstorm from yesterday and start planning what their Dream School will look like from the outside including infrastructure surrounding the neighborhood/school property. Encourage the teams to continue to update their Dream School Engineering Challenge Planning Guide.

Depending on the number of students per team, you may wish to assign several students to design the building and surrounding property while other members of the team design a sample classroom or other feature inside the school.

Math Extension: Demonstrate to students how to draw their plans to scale

(<http://tinyurl.com/7I5wmbo>) using a ruler. Discuss the different ratios using the ruler (e.g., 1 cm represents 10 feet, 1 block represents 25 square feet, etc.).

Modeling the Dream School (15-25 minutes)

After each team has presented their sketches to you, distribute materials and allow them to begin working on the model of their Dream School.

Day Two - Phase Four (30 minutes)

Allow teams to continue working on their model, adding new ideas to their Dream School Engineering Challenge Planning Guide. Walk around and ask questions about their designs. Encourage them to bring additional materials from home if they have ideas on what would be helpful to represent portions of their Dream School.

Day Three - Phase Five (45 minutes)

Challenge each team to include special measures such as plant beds that help mitigate erosion. Have teams update their Dream School Engineering Challenge Planning Guide. Allow teams to continue working on their design. Walk around and ask questions about their designs.

Encourage them to bring additional materials from home if they have ideas on what would be helpful to represent portions of their Dream School.

Optional activity: Create clay or paper mache from dryer lint (<http://tinyurl.com/cokqw>) with the teams to use in their Dream School models.

Day Three - Phase Six (40 minutes)

Allow teams to continue working on their design and ensure that they are updating their Dream School Engineering Challenge Planning Guide. Walk around and ask questions about their designs. Help them manage their time by informing them that they will have one more block of time dedicated to designing their model tomorrow and then they will begin working on the marketing plan/presentation.

Day Four - Phase Seven (45 minutes)

Allow team to finish building the model of their Dream School taking into account what they learned about an area's subsurface layers, soil, and rock types. At this point, they should have their Dream School Engineering Challenge Planning Guide completed. They will refer to the information on the planning guide during the next two phases.

Day Four - Phase Eight (55 minutes)

Have each team refer to their Dream School Engineering Challenge Planning Guide. Explain to them that they will now work together to develop a marketing plan to introduce their Dream School to the community.

Encourage each group to make sure their marketing plan includes:

- What is the one big idea that will make your school special?
- What special features or additional "selling points" do you want your community to know about the school?

- Highlight the design considerations you made to account for geological settings and phenomena such as earthquakes, erosion, landslides, etc.

Decide upon the format of the teams' marketing plans and/or allow them to choose from a variety of options.

- Poster board (individual or team)
- PowerPoint or Keynote presentation
- Public Service Announcement video
- Digital Poster board
 - Discovery Education Student Board Builder – <http://www.discoveryeducation.com>
 - Smore - <https://www.smores.com>

Have the teams begin the initial design of their marketing plan, assigning roles within the teams as needed. They will have time today and one hour tomorrow to finish their marketing plan.

Day Five - Phase Nine (60 minutes)

Have each team refer to their Dream School Engineering Challenge Planning Guide. Explain to them that they will now work together to finish their marketing plan that will be used to introduce their Dream School to the community.

Day Five - Phase Ten (30 minutes)

Teams prepare their models and rehearse their marketing plans to present during the STEMtastic Friday Celebration.