Engineering Project Planning

Turning Climate Change Knowledge Into Action

Description

Students work in groups to plan and implement an engineering project in their school and/or community to help achieve solutions related to human-caused climate change.

Problems

Water Module: Due to increased temperatures, increased variability in precipitation patterns, and increasing population in New Mexico, it is anticipated that water availability for domestic, commercial, and agricultural use will decline.

Energy Module: Due to human production and use of energy, Earth's climate is changing, creating social, economic, and environmental problems.

Design Challenge

Design and implement a solution in your school and/or community that reduces future climate change and/or helps adapt to changing climate conditions.

Objectives

Students will:

- Use the engineering design process and collaborate with classmates to design and implement a project
- Evaluate the success of their project
- Turn their climate change knowledge into action

Grade Level

5 – 8

Time

5 + Hours

Materials

- *Engineering Project Planning Guide* [1 per student, optional]
- Computer and projector* [optional]
- Computers and/or iPads for students to research* [optional]

*Not included in kit

Background

Now that students have made sense of a climate change phenomenon related to water or energy issues in New Mexico, it is time for them to turn their new understanding into engineering projects in their school and/or community. We use the term "engineering" as defined in A Framework for K-12 Science Education as "a systematic practice of design to achieve solutions to particular human problems."

Engineering projects can take various forms (e.g., educational campaigns, public events, fundraising campaigns to support further climate change recognition) and last for varying durations, from a one-time

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event to a long-term solution in their school and/or community. Examples of past New Mexico Climate Champions projects include fundraising for school solar panels, teaching younger students about renewable and non-renewable energy through hands-on activities, installing a rainwater harvesting barrel, planning a bike-a-thon to encourage students to use alternative forms of transportation, lobbying the city council to start a recycling program, and creating informational videos about how to make a difference. These projects are an opportunity for students to engage in the engineering design process by taking a problem presented to them and developing a solution.

How you approach action projects with your students is ultimately up to you. After all, you know your students, how they work together, and how they work best. Below we have included some suggestions based on New Mexico Climate Champions programs with various age groups in a variety of settings. We also have included an *Engineering Project Planning Guide* with a corresponding slide show that has been useful in helping students organize their planning.

Projects are an opportunity for students to do something about climate change! After introducing students to the realities of climate change, it is crucial for them to feel that they are part of the solution. Many students feel empowered by project planning and execution, ultimately feeling that they are making a difference in the world.

Tips for Entire Class Participation

- Group students in a way that is conducive to each student feeling included in the planning process. A detailed project plan with assignments for specific individuals allows everybody to contribute and play an integral role.
- With larger student groups, create sub-groups with specific responsibilities so everybody can stay engaged in a part of the project.
- Give students some say in their project topic, so they feel accountable and empowered by their projects.

Engineering Project Planning Guide

The *Engineering Project Planning Guide* is a framework to support students in planning their projects. This guide moves students through five stages of project planning simplified from the eight-step Engineering Design Process: (1) identifying the problem and constraints, (2) brainstorming and selecting the best solution, (3) planning the prototype project, (4) executing the project, and (5) evaluating progress to identify ways to improve the project. Stages 3 – 5 are iterative; we expect students to move between them freely as dictated by their projects' progress and results. The *Engineering Project Planning Guide* uses an example project designed by Asombro Institute staff for New Mexico Climate Champions. You may use as much or as little of this guide as you would like. We have provided an introductory slide show corresponding with the *Engineering Project Planning Guide*.

A Few Notes on Student Grouping

The method of choosing student groups and group sizes is dependent on your students' personalities and how they work together. The size of the student groups impacts the scale of projects, the time it takes to make decisions, and the time it takes to complete the project.

Start by determining group sizes for your class. We have listed some group sizes that we have worked with below, including some advantages and disadvantages.

- 1 – 4 students per group: Quicker decision-making and more communication about the status of the whole project is possible. Small groups may limit some students when deciding on the scale of the project they want to pursue since smaller-scale projects are more feasible when group sizes are small.

- 5 – 10 students per group: Students can be broken into sub-groups (e.g., marketing, logistics, communication) that can take different responsibilities. There are more opportunities for students to take initiative within sub-groups. Decision-making and communication may be challenging, with many different personalities vying for leadership.
- 15 – 30 students per group (usually half a class or an entire class): Allows for groups to take on more significant projects, but these groups must be split into sub-groups to ensure each student has a role. Decision-making can take time and require substantial support from the educator.

Generally, the larger the group, the more intervention needed from the educator to keep students on track and organized. Larger groups also require more intentional communication than smaller groups that can check in consistently. On the other hand, small groups mean the educator is stretched between multiple groups that may need assistance. Depending on your students, class sizes, potential project ideas, and classroom procedures, it may be helpful to identify your ideal group size before placing students into groups and determining project topics.

Below are some methods for choosing student groups:

- Students choose groups based on topics. Brainstorm a list of project ideas with your students. Determine how many groups you will have and then identify the same number of project ideas from the brainstorm list. By a draw of names, have students sign up for their choice of project topic. Once a project topic reaches its maximum number of students, the rest of the students must choose from the remaining project topics until they are placed in a group.
- Students choose groups on their own. This method allows students to work with classmates of their choice. A challenge with students choosing their groups before identifying the project is that they may disagree about where they would like to focus.
- You create student groups with or without student input. This option saves time if project planning time is limited, but it can leave students feeling less ownership of their projects.

Engineering Project Stages

The following sections of this teacher guide detail each stage of the *Engineering Project Planning Guid*e that you can use to assist students.

Slide 1: Let students know that they will now take their climate change knowledge and put it into action to design and implement a solution.

Slide 2: When engineers work to solve problems, they go through an eight-step engineering design process. We are going to use a simplified version of this process to design and implement our projects. Notice that stages 3, 4, and 5 have two-way arrows. This symbol means that groups should move freely between these stages according to the results and needs of their projects.

Stage 1: Identify the Problem and the Constraints

Slide 3: Students should be thinking about the problem they are trying to solve throughout the planning process. The problem statement was introduced to students during the final activity of the water or energy module. While the last activity of each module focused on a small-scale, personal solution to the problem, the engineering project allows students to think about addressing the issue on a larger scale. Posting the problem statement prominently in the classroom can help students keep the problem at the forefront of their thinking in Stage 2 and beyond. Have students write the problem they are trying to solve on #1 of their *Engineering Project Planning Guide*.

Students should also think about what constraints will be in place as they move forward. The educator will set the project constraints, which can be broad or specific. They should include details such as group size, amount of money available for the projects, locations, deadlines, etc. Have students write these constraints on #2 of the *Engineering Project Planning Guide*.

Stage 2: Brainstorm and Select the Best Solution

While we have found that students feel empowered when given an opportunity to participate in the project brainstorming and decision-making process, this may not be realistic in your classroom based on time or other constraints. Another option is to have ideas that you present to your students as their options for projects.

If students will be choosing their project ideas, here are some things to consider:

- Encourage students to brainstorm project ideas as they complete the five content activities. If students brainstorm two project ideas at the end of each lesson, they will have a starting list of 10 ideas when you begin project planning.
- Students seem empowered by their ideas being represented. They also take ownership when they can relate their solutions back to the phenomenon-based activities.
- The brainstorm list can be used to help group students (mentioned above). This option allows students to be organized by the solution in which they are most interested. In this scenario, students have a starting point when they begin to discuss details of their project.
- If students are not grouped by solution, they can reference the brainstorm list to discuss possible ideas.

Slide 4: If your students choose their projects, remind them to make sure their projects solve the problem we identified and work within the framework of the constraints you outlined.

Stage 3: Plan the Prototype Project

Slide 5: We encourage students to plan before executing their projects. Detailed planning may be unfamiliar to many students. Here are some considerations for guiding your students through project planning:

- Have students make a list of every task that needs to be completed. If each task has a specific deadline, it can keep the project moving forward. There is an example on this slide (and on student handouts) from a project done by Asombro staff for NM Climate Champions.
- It may be worthwhile to require students to submit a plan and have it approved before executing their project.
- Encourage students to assign specific group members to tasks. This way, everybody has a role in making the project a success.
- Remind students that plans change, and while they will likely be adding and removing things from their plan as challenges arise, it is vital to start with a framework for how they will achieve their goal of solving the problem identified in Stage 1.

Stage 4: Execute the Project

Slide 6: Once students have planned their project, they are ready to execute. Here are some things to consider when supporting your students in project execution:

- Encourage communication within groups. Communication could be daily or weekly check-ins regarding the status of their project. If students are in sub-groups, each sub-group needs to report to the whole group on their tasks. Bigger groups require more intentional communication.
- Remind students that as they execute their project, their plans may change, which is a normal part of project planning.
- Encourage students to keep their problem and proposed solution in mind and constantly evaluate if they are on track to meet their end goal.

Stage 5: Evaluate Progress Throughout and Identify Ways to Improve the Project

Slide 7: Let students know that they should constantly evaluate their project and look for ways to improve it. This step is a critical component of engineering design. The *Engineering Project Planning Guide* instructs students to reflect on successes (#7) and challenges (#8) at least once during the project period, but you should encourage students to constantly improve their projects as they execute them.

At the end of the project, students should evaluate their project's success in solving the problem they identified in Stage 1. They should provide evidence to support their claim. Finally, students should reflect on changes they would make if they were starting their project again.

Final Note

Slide 8: Congratulate students on planning and carrying out a project to solve a problem related to climate change in New Mexico. Designing and implementing a project can be a gratifying experience for students. We must give students an opportunity to feel like they can make a difference regarding climate change. The only way we will see change is to have people who are empowered to be active agents of change. Engineering projects give students real-world experience in project planning and organizing while learning how to be these agents of change.