



There's No Place Like Home: Designing Tornado-proof Structures (Resource Exchange)

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Target Grade – Third Grade

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Overview & Objective

A STEM integrated problem-based curriculum was developed for third grade, designed to address the *NGSS Standards*, the *Common Core Mathematics Standards*, and *Computer and Technology Standards*. The main objective of the project was to develop curriculum that could support the adoption of the NGSS Standards in the state of Nevada while providing students with an integrated learning experience that could promote achievement among diverse learners. The long-term goals of the project were to pilot, revise, and expand upon the curriculum for other grade levels.

One unit in particular, as part of this larger project, was a six-week lesson focused on an engineering design challenge related to weather and climate. Students in third grade learned about weather, climate, weather patterns, and various hazards associated with weather. Then they applied their learned knowledge and the engineering design process to design a tornado proof structure. As a cumulative experience of this lesson students were provided an opportunity to visit a local news station, meet a meteorologist, and learn about climate data.

Activity

Students attended a STEM class for one hour every week for sixty minutes. This class was a required special just like art or music. It was designed to expose students to the engineering design process, careers in engineering, and integrated STEM units based on state standards. It was in this class that students participated in the weather and climate six-week engineering design lesson. Engineering design framework and engineering concepts were woven throughout the unit. This lesson supported the NGSS, and Common Core Math, ELA and Technology standards. Specifically, this lesson aligns with the 3-ESS3-1, in which students make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard. Students were asked to think beyond the most common weather hazards that occurs in their community. Tornadoes were chosen as a hazard due to their rarity in the state. Students engaged in the engineering design process to design and test their tornado proof structures, each week focusing on a different process.

Procedures

At the start of the lesson, students were assigned to teams. There were a total of six teams (24 students). They worked in fours, with each team member assigned one of the following roles: *systems engineer*, *structural engineer*, *reporting engineer*, and *materials engineer*. The systems engineer researched for ways to solve the problem. The structural engineer was the creator that refined possible design solutions. The reporting engineer summarized the findings and presented the prototype. The materials engineer gathered materials to build the prototype based on the recommendation of the systems engineer's research and the structural engineer's design.

As students engaged in the problem solution using the engineering design process (Table 1), they learned about weather and climate, weather patterns, weather hazards, weather proof structures, and engineering design. Students conducted research on their Chromebooks, watched

videos, and read books to gather enough information to assist them with their design. They *asked* questions, *imagined* and *planned* possible solutions, *created* and *improved* their prototype, and *shared* their design solutions. The constraints of the prototype included using only the provided materials (e.g. craft sticks, empty paper towels, or cardboard). The height of the structure could not be smaller than 15 cm, with an entrance and exit that could open and close. In future iterations of this lesson, teachers could provide students with a budget from which they would have to ‘purchase’ materials.

Materials

Students had access to computers, books about weather and climate, climate data, and building materials (e.g., cardboard, scissors, craft sticks, masking tape, construction paper, rulers, pencils, and empty paper towel rolls). A leaf blower was used to test the stability of their structure.

Assessment

Formative assessments were conducted via discussion, observation, and daily written student reflections. Students reflected each day on their experience and identified two things that they learned. Additionally, summative assessments occurred at the end of the activity, which included creating the tornado proof structure and presenting it to the class. Students had to create a PowerPoint presentation, one per group, to share their structure. The presentation included images of their structure test and an explanation of why their structure was more capable of withstanding a tornado. Furthermore, students completed an end of unit assessment. The assessment included 20 multiple-choice questions and five open-ended questions.

Table 1: The engineering design process by week

Week	EDP	Activity
1	ASK	<ul style="list-style-type: none"> Read the problem, identify questions to ask about constraints Watch https://www.youtube.com/watch?v=zz_CRzcIT-Q Create a list of questions that would aid in development
2	IMAGINE	<ul style="list-style-type: none"> Imagine possible design solutions Watch https://www.youtube.com/watch?v=QVZExLO0MWA Implement ideas from video and other sources in design solutions
3	PLAN	<ul style="list-style-type: none"> Read the book, “<i>Tornado Alter</i>” by Franklyn M. Branley. https://www.amazon.com/Tornado-Alert-Lets-Read-Find-Out-Science/dp/0064450945 Research the causes of a tornado Plan several possible solutions by writing ideas down in a notebook
4	CREATE	<ul style="list-style-type: none"> Finalize one solution before gathering materials to create prototype Transfer solution to graph paper including measurements/materials When ready to test, go outside to test [TA was available]
5	IMPROVE	<ul style="list-style-type: none"> Improve and finalize design and prepare presentations
6	SHARE	<ul style="list-style-type: none"> Share structure prototype (presentation) and explain the design