

Brenda Williams  
STEM Leadership Seminar  
Mandatory 4 Assignment

- I. The “E” in STEM
- II. On September 29, 2018, I presented professional development (PD) to the University of North Texas (UNT) Science, Technology, Engineering, and Mathematics (STEM) Collaborative on the campus of UNT. The PD provided participating educators with knowledge regarding the steps of the engineering design process (EDP).

The UNT STEM Collaborative, formerly known as the UNT Texas Regional Collaborative for Excellence in Science and Mathematics Teaching (TRC), attendees are a close-knit group of PreK-12 science educators who have worked collaboratively for twenty-five years. I was a member of the UNT TRC for eight years. This group, until May, 2018, met one Saturday each month under the direction of two UNT professors. Due to a lack of federal funding supporting all TRCs across the state of Texas, in June, 2018, the UNT TRC dissolved and became known as the UNT STEM Collaborative due to its increased focused on STEM education. The UNT STEM Collaborative will remain under the direction of one UNT professor and will meet three to four times each year at the Environmental Science Building on the UNT campus in order to share STEM ideas, activities, and provide professional development. The membership of the UNT STEM Collaborative consists of charter school and public-school teachers from across the Dallas/Fort Worth Metroplex, and membership numbers as well as grade levels vary from one meeting to the next. Most PD is directed toward middle school so that teachers can level the activities up or down. There were thirteen teachers in attendance during my PD at the September meeting. These thirteen educators included: one self-contained kindergarten teacher, one self-contained second grade teacher, three sixth grade science teachers, four eighth grade science teachers, one eighth grade STEM teacher, one high school physics/astronomy teacher, one college physics professor, and one college elementary science education professor.

- III. My PD, *The “E” in Engineering*, addressed the Next Generation Science Standards (NGSS) and the Texas Essential Knowledge and Skills (TEKS) which are the K-12 education standards adopted by the Texas State Board of Education. Unlike the Next Generation Science Standards (NGSS), the TEKS do not specifically address engineering standards. Texas educators align their engineering lesson plans as close as possible to the TEKS, including TEKS addressing the scientific process. For a complete list of the standards for my PD, please see Appendix A.

IV. The purpose of my PD was to provide participating teachers with a deeper understanding of the EDP. Throughout my membership, the UNT STEM Collaborative educators have participated in a variety of engineering activities such as building a spaghetti tower, creating a chair for Goldilocks, and designing a purse made from duct tape. While these activities were thoroughly engaging, the lessons lacked a clear correlation to the engineering design process (EDP). Participating teachers were given materials and told to build a prototype that solved a problem. Preliminary brainstorming was not recorded and an initial design plan was not created. Throughout my eight-year membership with the collaborative, we have not been trained on the steps of the EDP.

V. The PD I developed included four pre-survey questions. While participating teachers provided answers showing some knowledge of the EDP, it was evident the teachers would benefit from further PD on the steps involved in the EDP.

1. What approaches do you take to solving open-ended engineering design problems presented in your classroom?
2. Are you familiar with the Engineering Design Process? If so, what are the steps in the engineering design process?
3. Have you integrated the Engineering Design Process into your science lessons? If so, provide an example.
4. What kinds of concerns do you have about engaging students in open-ended engineering design projects?

VI. The one-hour professional development included pre-survey questions, a Google Slide presentation, whole group discussions, post-survey questions, and an opportunity for participating teachers to pick up two sample EDP lesson plans. Following the pre-survey questions, I shared a Google Slide presentation which included: the objective for the PD, a definition of STEM, and projected percentage increases in STEM jobs from 2010-2020 ([https://docs.google.com/presentation/d/1WzVq8rpUXEUpGgDAk2axxGeD1dI4gq\\_b3V8v6qmNKqw/edit?usp=sharing](https://docs.google.com/presentation/d/1WzVq8rpUXEUpGgDAk2axxGeD1dI4gq_b3V8v6qmNKqw/edit?usp=sharing)).

Next, the Google Slide presentation included the benefits of teaching the EDP, and the importance of implementing the EDP in the elementary grades. The presentation also included links to two videos. The first video included children explaining why they enjoy participating in engineering design-based classes (<http://stemforall2016.videohall.com/presentations/703>). The teachers in the first video explained why they chose to implement engineering design-based lessons. The second video highlighted a conversation between Bill Gates and a Washington State teacher of the year (<https://www.gatesnotes.com/Education/Teaching-Engineering-to-a-5-Year-Old>). The teacher explained how she integrates engineering design-based learning with her kindergarten students.

I also included a slide on the core ideas behind the engineering design process. I referenced the Next Generation Science Standards' (NGSS) core ideas which state:

- A. Defining and delimiting engineering problems involves stating the problem to be solved as clearly as possible in terms of criteria for success, and constraints or limits;
- B. Designing solutions to engineering problems begins with generating a number of different possible solutions, then evaluating potential solutions to see which ones best meet the criteria and constraints of the problem; and
- C. Optimizing the design solution involves a process in which solutions are systematically tested and refined and the final design is improved by trading off less important features for those that are more important (NGSS Lead States, 2013).

My PD and Google Slides explored two different types of EDP models (see Appendix B and C). I shared the model used by NASA as well as the model preferred by PBS' Design Squad. I stressed the models are not linear. I included the importance of teachers choosing the model that works best for their students.

The next portion of my PD and Google Slides explored how NASA can assist teachers in learning about the EDP (<https://www.nasa.gov/audience/foreducators/best/edp.html>). I explained that NASA has a series of BEST videos that guide educators through the EDP (Ask, Imagine, Plan, Create, Experiment, and Improve) and helps educators introduce students to the methods that engineers use to approach and solve design challenges (NASA, 2018). The main portion of my PD focused on the NASA EDP video series. Throughout the video series, participating teachers utilized a workshop notepad that included questions emphasizing important concepts (see Appendix D). Between each short video, I gave teachers time to answer the workshop notepad questions and guided the teachers through whole group discussions which focused on the workshop notepad questions.

The final part of my PD included a final discussion of thoughts and ideas as well as sharing a variety of resources. I provided teachers with an assortment of EDP resources with QR codes (see Appendix E). Since the participating educators teach science, I provided an example of two science lessons which allowed teachers to see how the EDP can be integrated into a 5E science lesson plan (see Appendix F).

- VII. The activities in the Pick-up Unit included two fifth grade science lesson plans which can be modified for third grade through eighth grade TEKS. The lessons plans are based on the 5E lesson plan model and include the addition of an engineering component. I refer to the lesson plans as the 6E model. The first lesson plan covers a unit on the water cycle. Students must complete the unit by designing a device to collect and conserve rainwater. The second lesson covers a unit on biomes. During the engineering portion of the unit, students must choose either a desert, arctic, or tropical biome and design a roof for a house that can withstand the harsh conditions of that particular environment.

- VIII. The NASA information in my PD was developed for the NASA BEST program (NASA, 2018). NASA created a series of short videos that thoroughly prepare educators for using the NASA BEST program and for integrating the EDP into classrooms. The BEST program combines the EDP with aeronautics and includes educator guides for grades K-2, 3-5, and 6-8.

Each of the one to two-minute videos include exemplary explanations of each step in the EDP: ask, imagine, plan, create, experiment, and improve. The six videos provide examples of children participating in the EDP while solving an aeronautic challenge. When viewers see the EDP in action, it makes the EDP more visual. The videos allowed the teachers in the UNT STEM Collaborative to fully understand the purpose of brainstorming and creating a design before building a prototype during the EDP.

- IX. The follow-up activity for my PD will occur when the UNT STEM Collaborative meets again on January 12, 2019. I will initiate an informal discussion pertaining to my PD and inquire as to the participating teachers experiences in integrating the EDP into their science lessons. Since we are a close-knit group, we often share successes, failures, and ideas. I will inquire as to the kinds of concerns the teachers still have about integrating all the steps of the EDP.

The post-evaluation questions included the following:

1. What approaches can you take to solving open-ended engineering design problems presented in your classroom?
2. What are the steps in the Engineering Design Process? Briefly explain each step.
3. What kinds of concerns do you still have about engaging students in open-ended engineering design projects?
4. How well did today's training increase your understanding of the Engineering Design Process?  
Not at all    Somewhat    Well    Very well  
Comments:
5. How likely are you to integrate the Engineering Design Process into one of your lessons this year?  
Not at all    Maybe    Very Likely  
Comments:

- X. The final data showed that all teachers in post-survey Question 1 stated they would use the steps of the EDP to solve open-ended engineering design problems. In the pre-evaluation, ten teachers stated they use the engineering design process when solving open-ended engineering design problems. Two teachers said they let their students build things, and another teacher said she lets her students research solutions before completing an inquiry project.

In the second question of the pre-survey, one teacher was able to list and explain all the steps of the EDP. In the post-survey, all thirteen teachers were able to list and explain the EDP steps. In the pre-survey, thirteen participating teachers were able to

provide an example of a lesson utilizing the EDP. These examples were shared when the group participated in the PD's final discussion.

All participating teachers expressed a concern regarding time and materials in both the pre-survey and post-survey regarding concerns in implementing open-ended design projects. During whole group discussions, teachers stated there is a tremendous focus on state standardized testing and a lack of funds which inhibit teachers from engaging in the EDP on a regular basis.

In the pre-survey, eight teachers said they were not familiar with all the steps in the EDP. Then, in the post-survey, no teachers expressed a concern regarding a lack of knowledge related to the EDP. In Question 4 of the post-survey, twelve teachers circled "very well" regarding how well the training increased their understanding of the EDP. One teacher circled "well" regarding the value of the training. Only two teachers left a comment. One teacher stated, "This will help me when creating lesson plans." The other teacher simply said, "Very helpful." All thirteen teachers in Question 5 said they were very likely to integrate the EDP into one of their lessons this year.

I would consider my PD to be a success because my objective, as stated in my Google Slides presentation, was to introduce the "E" in STEM and teach all the steps of the Engineering Design Process so that educators could introduce students to a process used by engineers to approach and solve a design problem. Also, during whole group discussions, teachers were able to share examples of how they integrate the EDP into their lessons. My PD allowed for collaboration which is a primary goal of the UNT STEM Collaborative. I feel certain the collaboration and videos in my PD shed light on the importance of including brainstorming and designing in EDP lessons.

My PD related to two articles we read in the STEM Leadership course. Theodore Stefan Kaniuka's study, *Toward an Understanding of How Teachers Change During School Reform: Considerations for Educational Leadership and School Improvement* (2012), revealed that teachers were surprised by the student growth of a reading program when teachers stuck with a program when they initially had doubts regarding its value. My project relates to this research since it has been proven that when teachers stick with the integration of the EDP, student reap many benefits such as improved student learning and achievement in mathematics and science (Lachapelle & Cunningham, 2014).

The second research study, *A Primer on Effective Professional Development* (DeSimone, 2011), relates to my PD since DeSimone suggests a basic model for successful PD. Her model includes the following: "1. Teachers experience professional development. 2. The professional development increases teachers' knowledge and skills, changes their attitudes and beliefs, or both. 3. Teachers use their new knowledge, skills, attitudes, and beliefs to improve the content of their instruction, their approach to pedagogy, or both. 4. The instructional changes that the teachers introduce to the classroom boost their students' learning (p. 70)." The post-survey in my PD showed an increase in teachers' knowledge of the EDP. In

December, when the UNT STEM collaborative meets again, I will be able to further assess the teachers' ability to improve the content of their instruction and determine how the EDP has improved student learning.

I enjoyed participating in the opportunity to lead a PD for the UNT STEM Collaborative. I have presented PD to this group before, but not to the extent as this particular PD. The "E" in STEM PD allowed me to share the knowledge I gained from completing a capstone project entitled Engineering Design-Based Learning Meets Earth Science in a Fifth Grade STEM Science Curriculum. With the addition of two Pick-up activities, participating science educators learned how to integrate the EDP into science lessons. Also, the participating educators are science mentors who are leaders on their own campuses. They share PD from the UNT STEM Collaborative with teachers on their campuses. Therefore, my PD may end up in the hands of many educators throughout the Dallas and Fort Worth Metroplex. I hope I can help educators positively impact student learning by encouraging teachers to implement the EDP.

## References

- Desimone, L. M. (2011). A primer on effective professional development. *Phi Delta Kappan*, 92(6), 68-71.
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- Lachapelle, C. P. & Cunningham, C. M. (2014). Engineering in elementary schools. In S. Purzer, J. Strobel, & M. Cardella (Eds.), *Engineering in pre-college settings: Research in synthesizing research, policy, and practices* (pp. 61–88). Lafayette, IN: Purdue University Press. Retrieved from [https://www.eie.org/sites/default/files/research\\_article/research\\_file/lachapelle\\_cunningham\\_2014\\_elementary\\_engineering.pdf](https://www.eie.org/sites/default/files/research_article/research_file/lachapelle_cunningham_2014_elementary_engineering.pdf)
- NASA. (2018). Beginning engineering, science, and technology (BEST). Retrieved from [https://www.nasa.gov/sites/default/files/best\\_intro\\_workbook.pdf](https://www.nasa.gov/sites/default/files/best_intro_workbook.pdf).
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## **XI. Appendices**

### Appendix A

#### **Standards Addressed**

##### **NGSS**

K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

HS-ERS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering (NGSS Lead States, 2013).

##### **NGSS Science and Engineering Practices**

Asking Questions and Defining Problems

Developing and Using Models

Planning and Carrying Out Investigations

Analyzing and Interpreting Data

Using Mathematics and Computational Thinking

Constructing Explanations and Designing Solutions

Engaging in Argument from Evidence (NRC, 2012)

##### **Science TEKS**

K.3 Scientific investigation and reasoning. The student knows that information and critical thinking are used in scientific problem solving. The student is expected to: (A) identify and explain a problem such as the impact of littering and propose a solution.

1.3 and 2.3 Scientific investigation and reasoning. The student knows that information and critical thinking are used in scientific problem solving. The student is expected to: (A) identify and explain a problem and propose a solution.

3.3 Scientific investigation and reasoning. The student knows that information, critical thinking, scientific problem solving, and the contributions of scientists are used in making decisions. The student is expected to: (A) analyze, evaluate, and critique scientific explanations by using evidence, logical reasoning, and experimental and observational testing.

4.3 and 5.3 Scientific investigation and reasoning. The student uses critical thinking and scientific problem solving to make informed decisions. The student is expected to: (A) analyze,

evaluate, and critique scientific explanations by using evidence, logical reasoning, and experimental and observational testing (Texas Education Agency, 2018).

6.3, 7.3, and 8.3 Scientific investigation and reasoning. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions and knows the contributions of relevant scientists. The student is expected to: (A) analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, so as to encourage critical thinking by the student (Texas Education Agency, 2018).

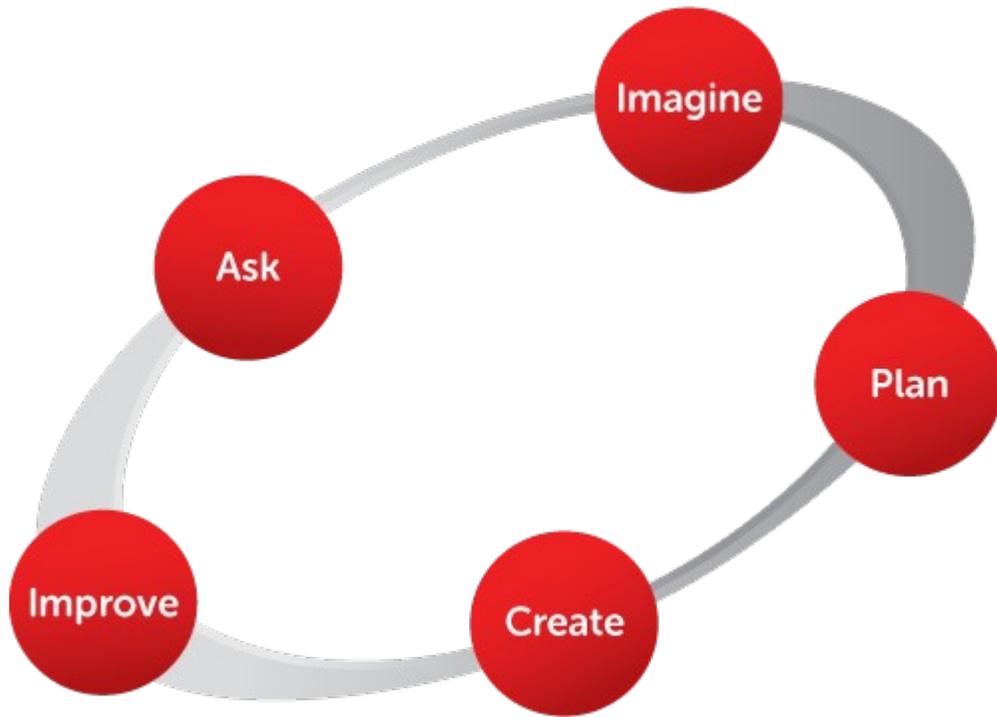
Aquatic Science, Astronomy, Biology, Chemistry, Earth and Space Science, Environmental Systems, Integrated, Integrated Physics and Chemistry, and Physics (3) Scientific investigation and reasoning. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions and knows the contributions of relevant scientists. The student is expected to: (A) analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, so as to encourage critical thinking by the student (Texas Education Agency, 2018).

### **Math TEKS**

5.1 Mathematical process standards. The student uses mathematical processes to acquire and demonstrate mathematical understanding. The student is expected to: (A) apply mathematics to problems arising in everyday life, society, and the workplace; (B) use a problem-solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution, and evaluating the problem-solving process and the reasonableness of the solution; (C) select tools, including real objects, manipulatives, paper and pencil, and technology as appropriate, and techniques, including mental math, estimation, and number sense as appropriate, to solve problems.

Appendix B

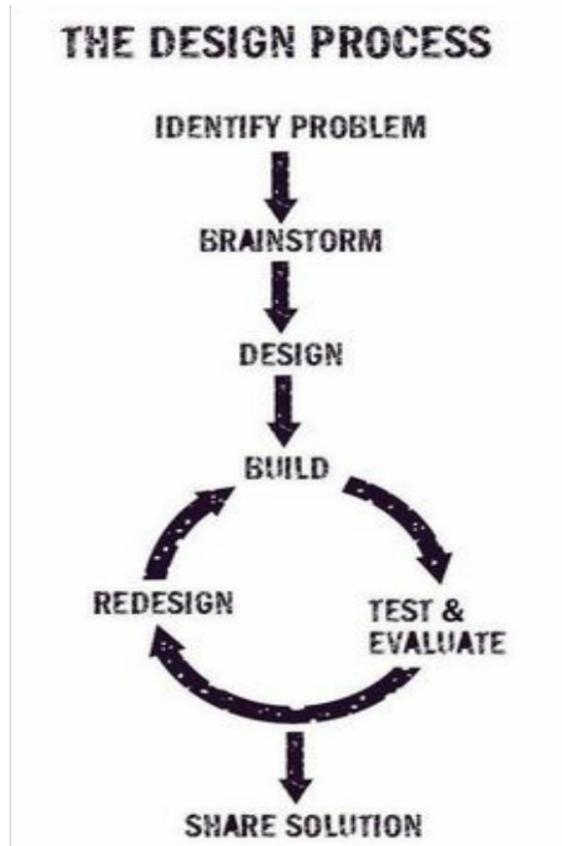
**NASA's Engineering Design Process**



Retrieved from <https://www.eie.org/overview/engineering-design-process>

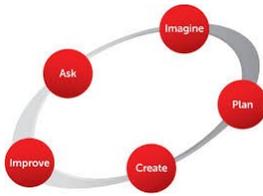
## Appendix C

### PBS Design Squad's Engineering Design Process



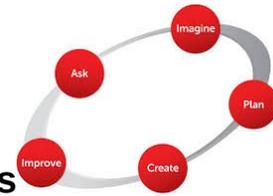
Retrieved from <http://pbskids.org/designsquad/parentseducators/workshop/process.html>

## Appendix D



### NASA's BEST EDP Video Series

<https://www.nasa.gov/audience/foreducators/best/edp.html>



#### Video #2—ASK

1. The first step in the engineering design process (EDP) is to ask. What does this mean?
2. Why is it important that students ask questions?

#### Video #3--IMAGINE

1. What does it mean to imagine? Why is this important?
2. Why should a teacher carefully monitor this step?

#### Video #4--PLAN

1. Why do engineers plan?
2. Why is it important that students be given an opportunity to plan before creating?
3. What's the best way to get your students to plan?

### **Video #5--CREATE**

- 1. Why do you think it's important that students begin the activity by following their original sketch?**

### **Video #6--EXPERIMENT**

- 1. Why is it important that students test, measure, and record during the experiment stage of the EDP?**

### **Video #7--IMPROVE**

- 1. Why is the EPD a cyclical process and not a linear process?**
  
- 2. Choose a lesson you teach. How could you integrate the EDP into this lesson?**

## Engineering Design Process Resources

### **\*The Ultimate STEM Guide for Kids: 239 Cool Sites About Science, Technology, Engineering and Math**

<https://www.mastersindatascience.org/blog/the-ultimate-stem-guide-for-kids-239-cool-sites-aboutscience-technology-engineering-and-math/>



This site provides over 200 links to K-12 STEM and engineering websites, games, apps, and career resources.

### **\*TryEngineering**

<http://tryengineering.org/>



This free resource provides engineering information, lesson plans, and activities.

### **\*TeachEngineering**

<https://www.teachengineering.org/>



Free K-12 STEM curriculum which integrates the engineering design process.

### **\*PBS Design Squad**

<https://pbskids.org/designsquad/>



Video series to show that engineering is fun, active and collaborative. The site contains many free lessons for all grade levels.

### **\*STEM Activities NASA/JPL**

<https://www.jpl.nasa.gov/edu/teach/>



While bringing the wonder of space to students, this site contains free K-12 lessons.

**\*NASA's BEST Students**

<https://www.nasa.gov/audience/foreducators/best/activities.html>



Beginning Engineering, Science, and Technology (BEST) contains free engineering lessons for grades K-8. All activities contain collaboration, math, and real-world content.

**\*eGFI**

<http://teachers.egfi-k12.org/>



Boost math, science with these free engineering lesson plans for K-12.

**\*My NASA Data**

[https://www.nasa.gov/audience/foreducators/5-8/features/F\\_MY\\_NASA\\_Data.html](https://www.nasa.gov/audience/foreducators/5-8/features/F_MY_NASA_Data.html)



This site contains a collection of resources, including free lesson plans, for all grade levels.

**\*The Concord Consortium**

<https://learn.concord.org/>



This website provides a variety of free K-12 STEM tools including lesson plans and interactive simulations that allow students to collect data.

**\*Exploratorium**

<https://www.exploratorium.edu/explore/engineering-tinkering>



Activities, videos, and more make this resource an interesting site to visit.

## Appendix F

### Pick Up Activities

#### Examples of 6E lesson plans with an EDP component

**Title:** Let It Rain

**Grade level:** Fifth Grade--can be adapted for grades 3-8

**Time Allotted:** Seven 45-minute lessons plus three or more days of wait time

**Learning Objectives:** Students will explore the water cycle process and determine the role of the Sun and the ocean in this process. Students will design a prototype of a water collection device that conserves water.

#### Next Generation Science Standards

5-ESS2-1 Develop a model using an example to describe the ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

5-ESS3-3 Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

3-5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5-ETS1-3 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved. (NGSS Lead States, 2013).

#### NGSS Science and Engineering Practices

Asking Questions and Defining Problems

Developing and Using Models

Planning and Carrying Out Investigations

Analyzing and Interpreting Data

Using Mathematics and Computational Thinking

Constructing Explanations and Designing Solutions

Engaging in Argument from Evidence (NRC, 2012)

#### Science TEKS

5.3 Scientific investigation and reasoning. The student uses critical thinking and scientific problem solving to make informed decisions. The student is expected to: (A) in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the

student; (D) connect grade-level appropriate science concepts with the history of science, science careers, and contributions of scientists.

5.4 Scientific investigation and reasoning. The student knows how to use a variety of tools, materials, equipment, and models to conduct science inquiry. The student is expected to: (A) collect, record, and analyze information using tools, including calculators, microscopes, cameras, computers, hand lenses, metric rulers, Celsius thermometers, mirrors, spring scales, pan balances, triple beam balances, graduated cylinders, beakers, hot plates, meter sticks, compasses, magnets, collecting nets, and notebooks; timing devices, including clocks and stopwatches; and materials to support observation of habitats of organisms such as terrariums and aquariums.

5.8. Earth and space. The student knows that there are recognizable patterns in the natural world and among the Sun, Earth, and Moon system. The student is expected to: (B) explain how the Sun and the ocean interact in the water cycle; (D) identify and compare the physical characteristics of the Sun, Earth, and Moon. (Texas Education Agency, 2017b).

### **Math TEKS**

5.1 Mathematical process standards. The student uses mathematical processes to acquire and demonstrate mathematical understanding. The student is expected to: (A) apply mathematics to problems arising in everyday life, society, and the workplace; (B) use a problem-solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution, and evaluating the problem-solving process and the reasonableness of the solution; (C) select tools, including real objects, manipulatives, paper and pencil, and technology as appropriate, and techniques, including mental math, estimation, and number sense as appropriate, to solve problems (Texas Education Agency, 2012).

### **ELAR TEKS**

5.7 Reading/Comprehension of Literary Text/Literary Nonfiction. Students understand, make inferences and draw conclusions about the varied structural patterns and features of literary nonfiction and provide evidence from text to support their understanding.

5.26 Research/Organizing and Presenting Ideas. Students organize and present their ideas and information according to the purpose of the research and their audience. Students are expected to synthesize the research into a written or an oral presentation that: (A) compiles important information from multiple sources; (B) develops a topic sentence, summarizes findings, and uses evidence to support conclusions; and (C) presents the findings in a consistent format.

5.27 Listening and Speaking/Listening. Students use comprehension skills to listen attentively to others in formal and informal settings. Students continue to apply earlier standards with greater complexity. Students are expected to: (A) listen to and interpret a speaker's messages (both verbal and nonverbal) and ask questions to clarify the speaker's purpose or perspective; and (C) determine both main and supporting ideas in the speaker's message.

5.29 Listening and Speaking/Teamwork. Students work productively with others in teams. Students continue to apply earlier standards with greater complexity. Students are expected to participate in student-led discussions by eliciting and considering suggestions from other group members and by identifying points of agreement and disagreement (Texas Education Agency, 2017a).

### **Technology TEKS**

(1) Creativity and innovation. The student uses creative thinking and innovative processes to construct knowledge and develop digital products. The student is expected to: (A) create original products using a variety of resources; and (C) use virtual environments to explore systems and issues.

(2) Communication and collaboration. The student collaborates and communicates both locally and globally using digital tools and resources to reinforce and promote learning. The student is expected to: (A) draft, edit, and publish products in different media individually and collaboratively; (B) use font attributes, color, white space, and graphics to ensure that products are appropriate for multiple communication media, including monitor display, web, and print; (C) collaborate effectively through personal learning communities and social environments; (D) select and use appropriate collaboration tools; and (E) evaluate the product for relevance to the assignment or task.

(3) Research and information fluency. The student acquires and evaluates digital content. The student is expected to: (A) use various search strategies such as keyword(s); the Boolean identifiers *and*, *or*, and *not*; and other strategies appropriate to specific search engines; (B) collect and organize information from a variety of formats, including text, audio, video, and graphics; (C) validate and evaluate the relevance and appropriateness of information; and (D) acquire information appropriate to specific tasks.

(4) Critical thinking, problem solving, and decision making. The student researches and evaluates projects using digital tools and resources. The student is expected to: (A) identify information regarding a problem and explain the steps toward the solution; (B) collect, analyze, and represent data to solve problems using tools such as word processing, databases, spreadsheets, graphic organizers, charts, multimedia, simulations, models, and programming languages; (C) evaluate student-created products through self and peer review for relevance to the assignment or task; and (D) evaluate technology tools applicable for solving problems.

(6) Technology operations and concepts. The student demonstrates knowledge and appropriate use of technology systems, concepts, and operations. The student is expected to: (A) demonstrate an understanding of technology concepts, including terminology for the use of operating systems, network systems, virtual systems, and learning systems appropriate for Grades 3-5 learning; and (D) troubleshoot minor technical problems with hardware and software using available resources such as online help and knowledge bases (Texas Education Agency, 2011).

### **Lesson Assessment**

Formative Assessment: Students will participate in formative assessment discussion questions throughout the lesson. Using a science journal/notebook or poster board, students will create a water cycle diagram. Students will complete an Engineering Design Process Matrix/Activity sheet.

Summative Assessment: A rubric will be used to assess the students.

### **6E Lesson Plan**

**Engage** (15 minutes)

Prior to teaching the lesson, the teacher will cut off the top of an empty water bottle for each group of students. Leave the cap screwed onto the water bottle and invert the cut top inside the water bottle so that it looks like a funnel.

Explain to students that they are to observe a model and determine what the model represents. Have students predict what will happen when very warm water is poured into the water bottle and an ice cube is placed in the inverted bottle top. Have students remove the cut inverted top from inside their water bottle, so the teacher can fill the water bottle half way with very warm water. The students will replace the cut inverted top so that it is inside the water bottle. The teacher will place an ice cube inside each group's inverted top, and the students will observe their water bottle. Students should note the condensation forming inside the water bottle.

Students will record what they have observed.

**Formative Assessment Discussion Questions:**

What did you observe in the water bottle?

Why did this happen?

How does this relate to Earth?

What is the role of the Sun in the water cycle?

What happens to the salt in the ocean when water is evaporated?

How does condensation form?

**Explore** (30 minutes + 45 minutes)

Show students a map of the world. Ask them what the color blue represents and how much of the Earth is covered by water. Ask if all the water on Earth is available for drinkable use. Allow students to predict the percentage of drinkable water by participating in an online polling system such as Mentimeter.

The teacher will pour 100 ml of water into a beaker and add a couple drops of blue food coloring. Explain this represents all the water on Earth. Pour 98 ml of the blue water into an empty beaker. Explain this represents the water in Earth's oceans and is too salty to drink. Fill a

pipette with the blue water and set it aside. Tell the students the water in the beaker represents the amount of freshwater on Earth, but it isn't available for drinking because it is stored in the polar ice caps and world's glaciers. Show the students the pipette. Explain that the amount of fresh water available on Earth for drinking is less than the amount of water in the pipette. Less than 1% of water on Earth is drinkable. As a class, read the following article about Earth's water--

<https://www.koshland-science-museum.org/water/html/en/Sources/Where-is-the-Earths-Water.html>

Formative Assessment Discussion Questions:

Does the amount of water in the pipette seem like enough for all the organisms on Earth to survive?

Why is it important to conserve water?

Is water renewable or nonrenewable resource? Why?

How can we conserve water?

Students will read the following article about the Sun, ocean, and water

cycle--<http://www.bsisd.esc18.net/documents/Lesson%20Ideas/LESSONS%20&>

[%20RESOURCES/SCIENCE/5th](http://www.bsisd.esc18.net/documents/Lesson%20Ideas/LESSONS%20&%20RESOURCES/SCIENCE/5th)

[%20Gr/Science Grade 05 Unit 08 Exemplar Lesson 02 Sun, Ocean, and the Water Cycle.pdf](http://www.bsisd.esc18.net/documents/Lesson%20Ideas/LESSONS%20&%20Gr/Science%20Grade%2005%20Unit%2008%20Exemplar%20Lesson%2002%20Sun,%20Ocean,%20and%20the%20Water%20Cycle.pdf).

The teacher will use the resources on the same web site to create water cycle headbands.

The direction for playing the Water Cycle Headband Guessing Game is also located on this site.

Students will use the information in the article to play the Water Cycle Headband Guessing Game.

**Explain** (45 minutes)

Students will view the following NASA video about the water cycle--

<https://pmm.nasa.gov/education/videos/earths-water-cycle>. Students will view the following

NASA video about the use of remote sensing and satellites to study water on Earth--<https://pmm.nasa.gov/education/videos/water-falls-getting-big-picture>.

Students will practice using the water cycle process while completing the online games located at [http://lessons.e-learningforkids.org/efk/Courses/EN/The Water Cycle/launch.html](http://lessons.e-learningforkids.org/efk/Courses/EN/The_Water_Cycle/launch.html).

Each student will design and explain a water cycle diagram in their science notebook or on poster board. Students may share their design and explanation with a partner or small group.

Formative Assessment Discussion Questions:

How does the water cycle affect life on Earth?

Why does the water cycle never end?

Why must evaporation occur before condensation??

Where does water go when it soaks into the ground? How is groundwater used?

The water for our community comes from a lake. How do you think lake water is turned into drinking water?

**Elaborate** (45 minutes)

It is essential that people around the world conserve water. There are many areas in Texas that are currently experiencing droughts. Visit the following web site to view a drought map for the United States--<http://droughtmonitor.unl.edu/>. The students' job is to design the best device to collect and conserve the most water. The water will be used for watering plants.

Create design teams of three to four students. Review the Engineering Design Process with students. Explain to students that they will be working in teams, utilizing the Engineering Design Process activity sheet.

Teams will have access to the following materials: cans with smooth edges, water bottles, plastic cups, recycled containers with lids, plastic wrap, cardboard tubes, rubber bands, aluminum foil, colored paper, graduated cylinders, tape, and a water can to represent rain.

Teams will draw and present their preliminary design to the class for review. Students may ask for further clarification from presenting teams. Students may offer ideas to improve each team's design. Teams may choose to add these ideas to their plan.

**Engineer** (two 45 minutes + three-five days wait time)

Teams will create their prototypes. When testing the prototypes, each team will fill the water can with 150 ml of water. The teacher will pour 150 ml of water over each prototype. The prototypes will be placed in a sunny area for three to five days, depending on the amount of direct sunlight. Then teams will measure the amount of water left in their prototype. Teams will post their results on a class spreadsheet. Teams can redesign their prototypes and repeat the process for collecting data.

Once teams have completed all their work, they will explain and share their final design. Teams will discuss why their final design is successful/not successful. As a class, discuss the results and encourage students to offer suggestions as to how each model could be improved. Remember to consider both materials and structural design.

After the assessment of the models, ask teams to list three positive and three negative aspects of their model. Students should collaboratively reflect and decide (and list) how they would improve their prototype if they were given any materials of their choice and how they would construct another (better) model with the new materials. Teams can create a Google Slide to share their reflections with the class.

**Evaluate** (45 minutes)

Students will discuss the steps in the water cycle. Students will review how the Sun and ocean affect the water cycle. Students will predict how future space explorers will have access to clean

drinking water. The students may use their science notebook to write what they have learned in this unit.

The teacher can evaluate student comprehension using the students' diagram of the water cycle.

The teacher can assess student comprehension as each team progresses through the Engineering Design Process activity sheet to research, brainstorm, design, build, improve, and reflect. A

rubric will be used to assess the students during the engineering design project. The students may use the rubric for self-assessment, and the teacher may use it for grading purposes.

### **Adjustments/Adaptations**

The teacher may choose to use a KLEWS chart throughout the lesson to reinforce concepts being taught. Students will work in small cooperative groups throughout the lesson. Each group member can choose a job card so that everyone is responsible for their group's project. Some students may need to partner read the article. Discussion questions are based on different levels of Bloom's Taxonomy. Groups are given choices in the Engineering portion of the lesson. The lesson considers different learning styles—visual, auditory, and kinesthetic. In order to make sure no water is spilled when collecting data, the teacher may want to pour the remaining water into the graduated cylinders.

### **Resources and Materials Needed**

The students will need: water bottles with the tops cut off and inserted into the water bottles like a funnel; very warm water; ice cubes; world map; online polling system such as Mentimeter; two 100 ml beakers; food coloring; pipette; cardstock headbands and vocabulary cards for the Water Cycle Headband Guessing Game; How the Sun and Ocean React article; science notebooks or poster board for creating a water cycle diagram; cans with smooth edges; water bottles; plastic cups; recycled containers with lids; plastic wrap; cardboard tubes; rubber bands; aluminum foil; colored construction paper; graduated cylinders; tape; and a water can to represent rain.

## Links

<http://www.bsisd.esc18.net/documents/Lesson%20Ideas/LESSONS%20&>

[%20RESOURCES/SCIENCE/5th](#)

[%20Gr/Science Grade 05 Unit 08 Exemplar Lesson 02 Sun, Ocean, and the Water Cycle.pdf](#)

<https://www.koshland-science-museum.org/water/html/en/Sources/Where-is-the-Earths-Water.html>

<https://pmm.nasa.gov/education/videos/earths-water-cycle>

<https://pmm.nasa.gov/education/videos/water-falls-getting-big-picture>

[http://lessons.e-learningforkids.org/efk/Courses/EN/The\\_Water\\_Cycle/launch.html](http://lessons.e-learningforkids.org/efk/Courses/EN/The_Water_Cycle/launch.html)

<http://droughtmonitor.unl.edu/>

## References

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Texas Education Agency. (2017b). Texas essential knowledge and skills for 5<sup>th</sup> grade. §112.15. Science. <http://tea.texas.gov>

## **Exploring Global Climate**

**Grade level:** Fifth Grade-can be adapted for grades 3-8

**Time Allotted:** Six 45-minute lessons

**Learning Objectives:** The student will differentiate weather from climate. The student will explore different biomes and their climates. The student is expected to design a house that can withstand a certain climate condition. Students will explain how different climates result in different design strategies and techniques to best create human shelters.

### **Next Generation Science Standards**

5-ESS2-1 Develop a model using an example to describe the ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

5-ESS3-3 Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

3-5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5-ETS1-3 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved (NGSS Lead States, 2013).

### **NGSS Science and Engineering Practices**

Asking Questions and Defining Problems

Developing and Using Models

Planning and Carrying Out Investigations

Analyzing and Interpreting Data

Using Mathematics and Computational Thinking

Constructing Explanations and Designing Solutions

Engaging in Argument from Evidence (NRC, 2012)

### **Science TEKS**

5.3 Scientific investigation and reasoning. The student uses critical thinking and scientific problem solving to make informed decisions. The student is expected to: (A) in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student; (D) connect grade-level appropriate science concepts with the history of science, science careers, and contributions of scientists.

5.4 Scientific investigation and reasoning. The student knows how to use a variety of tools, materials, equipment, and models to conduct science inquiry. The student is expected to: (A) collect, record, and analyze information using tools, including calculators, microscopes, cameras, computers, hand lenses, metric rulers, Celsius thermometers, mirrors, spring scales, pan balances, triple beam balances, graduated cylinders, beakers, hot plates, meter sticks, compasses, magnets, collecting nets, and notebooks; timing devices, including clocks and stopwatches; and materials to support observation of habitats of organisms such as terrariums and aquariums.

5.8 Earth and space. The student knows that there are recognizable patterns in the natural world and among the Sun, Earth, and Moon system. The student is expected to: (A) differentiate between weather and climate; and (D) identify and compare the physical characteristics of the Sun, Earth, and Moon. (9) Organisms and environments. The student knows that there are relationships, systems, and cycles within environments. The student is expected to: (A) observe the way organisms live and survive in their ecosystem by interacting with the living and non-living elements (Texas Education Agency, 2017b).

### **Math TEKS**

5.1 Mathematical process standards. The student uses mathematical processes to acquire and demonstrate mathematical understanding. The student is expected to: (A) apply mathematics to problems arising in everyday life, society, and the workplace; (B) use a problem-solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution, and evaluating the problem-solving process and the reasonableness of the solution; (C) select tools, including real objects, manipulatives, paper and pencil, and technology as appropriate, and techniques, including mental math, estimation, and number sense as appropriate, to solve problems.

5.2 Number and operations. The student applies mathematical process standards to represent, compare, and order positive rational numbers and understand relationships as related to place value. The student is expected to: (A) represent the value of the digit in decimals through the thousandths using expanded notation and numerals; (C) round decimals to tenths or hundredths (Texas Education Agency, 2012).

### **ELAR TEKS**

5.7 Reading/Comprehension of Literary Text/Literary Nonfiction. Students understand, make inferences and draw conclusions about the varied structural patterns and features of literary nonfiction and provide evidence from text to support their understanding.

5.26 Research/Organizing and Presenting Ideas. Students organize and present their ideas and information according to the purpose of the research and their audience. Students are expected to synthesize the research into a written or an oral presentation that: (A) compiles important information from multiple sources; (B) develops a topic sentence, summarizes findings, and uses evidence to support conclusions; and (C) presents the findings in a consistent format.

5.27 Listening and Speaking/Listening. Students use comprehension skills to listen attentively to others in formal and informal settings. Students continue to apply earlier standards with greater complexity. Students are expected to: (A) listen to and interpret a speaker's messages (both verbal and nonverbal) and ask questions to clarify the speaker's purpose or perspective; and (C) determine both main and supporting ideas in the speaker's message.

5.29 Listening and Speaking/Teamwork. Students work productively with others in teams. Students continue to apply earlier standards with greater complexity. Students are expected to participate in student-led discussions by eliciting and considering suggestions from other group members and by identifying points of agreement and disagreement (Texas Education Agency, 2017a).

### **Technology TEKS**

(1) Creativity and innovation. The student uses creative thinking and innovative processes to construct knowledge and develop digital products. The student is expected to: (A) create original products using a variety of resources; and (B) analyze trends and forecast possibilities, developing steps for the creation of an innovative process or product.

(2) Communication and collaboration. The student collaborates and communicates both locally and globally using digital tools and resources to reinforce and promote learning. The student is expected to: (A) draft, edit, and publish products in different media individually and collaboratively; (B) use font attributes, color, white space, and graphics to ensure that products are appropriate for multiple communication media, including monitor display, web, and print; (C) collaborate effectively through personal learning communities and social environments; (D) select and use appropriate collaboration tools; and (E) evaluate the product for relevance to the assignment or task.

(3) Research and information fluency. The student acquires and evaluates digital content. The student is expected to: (A) use various search strategies such as keyword(s); the Boolean identifiers *and*, *or*, and *not*; and other strategies appropriate to specific search engines; (B) collect and organize information from a variety of formats, including text, audio, video, and

graphics; (C) validate and evaluate the relevance and appropriateness of information; and (D) acquire information appropriate to specific tasks.

(4) Critical thinking, problem solving, and decision making. The student researches and evaluates projects using digital tools and resources. The student is expected to: (A) identify information regarding a problem and explain the steps toward the solution; (B) collect, analyze, and represent data to solve problems using tools such as word processing, databases, spreadsheets, graphic organizers, charts, multimedia, simulations, models, and programming languages; (C) evaluate student-created products through self and peer review for relevance to the assignment or task; and (D) evaluate technology tools applicable for solving problems.

(6) Technology operations and concepts. The student demonstrates knowledge and appropriate use of technology systems, concepts, and operations. The student is expected to: (A) demonstrate an understanding of technology concepts, including terminology for the use of operating systems, network systems, virtual systems, and learning systems appropriate for Grades 3-5 learning; (C) navigate systems and applications accessing peripherals both locally and remotely; and (D) troubleshoot minor technical problems with hardware and software using available resources such as online help and knowledge bases (Texas Education Agency, 2011).

### **Lesson Assessment**

**Formative Assessment.** Students will participate in formative assessment discussion questions throughout the lesson. Using a science journal/notebook, students will create a Circle Thinking Map and write what they have learned in this lesson.

**Summative Assessment.** A rubric will be used to assess the students.

### **6E Lesson Plan**

#### **Engage** (5 minutes)

Students will view the following image--

<https://www.nasa.gov/feature/goddard/2018/nasa-measures-heavy-us-rainfall-from-space>.

Formative Assessment Discussion Questions:

What is the difference between weather and climate?

Is this map an example of weather or climate? Why?

How many days were used for data collection?

Which states received more than 15 mms of rain each day? Fifteen mm of rain is equivalent to

how many cm?

What can we infer about the areas in yellow?

What do you think scientists can learn about Earth by using this image?

#### **Explore** (40 minutes)

The following directions and questions are based on NASA Jet Propulsion Laboratory, (April, 2012).

Explain to students they will be analyzing average temperatures measured on Earth for the past 136 years, but each group will only be looking at a portion of that data. Distribute the global temperature data, either as a whole set or pre-divided for individuals or groups--

[https://www.jpl.nasa.gov/edu/pdfs/global\\_monthly\\_temp\\_anomalies\\_1880-2016.txt](https://www.jpl.nasa.gov/edu/pdfs/global_monthly_temp_anomalies_1880-2016.txt). Distribute graph paper.

1. The data file for this activity contains 137 years of average global annual temperature measurements. Depending on class size, the steps in “Procedures” can be done by individuals or groups of students.
2. Divide the data so that each group or individual has approximately the same number of data points.
3. Help students determine an appropriate vertical scale. Determine the range of data by subtracting the maximum and minimum temperature values (e.g.,  $14.87 - 13.54 = 1.33$ ). Placing the graph paper in portrait orientation allows for approximately 40 lined intervals. Determine scale by asking which place value (ones, tenths, hundredths, etc.) should be used. Demonstrate that counting by ones on each line will not allow for accurate resolution of data. Have students determine how many lines they will need if they count by tenths and if they count by hundredths.
4. Help students determine an appropriate horizontal scale. It is important to evenly space the years. When all graph axes are labeled and teacher-approved, have students proceed with plotting their data points.
5. Monitor students closely while they are plotting data points to be sure they are using a consistent scale. A consistent scale allows data to be combined seamlessly and accurately.

Instruct students to make their data point dots large and dark so they will be visible when their graph is held up for the class. Students will use a ruler to connect their data points.

6. When individual graphs are complete, have students determine if they see an increase or decrease in mean global temperature for their group's time frame. Discuss the risk of making climate assumptions and projections when looking at a small data set.
7. Have students tape their graphs to the whiteboard and line them up horizontally, by year, maintaining equal spacing between all the years. When combining individual graphs into the class graph, be sure to fold back or cut off extra paper so that the year spacing remains constant throughout the graph. Ask students to examine the data and determine which value, year or annual mean temperature, should go on the vertical axis. Although it can be done either way, annual mean temperature should go on the vertical axis for ease of viewing.
8. Have students stand back and assess the trend. Is there a trend of global temperature increase or decrease?
9. Ask students if this trend has always been the case over the past 136 years? If not, when did the trend shift?
10. Have students guess why the trend shifted, then have them research the years when the trend shifted.
11. Have students predict global temperature means for the subsequent year. Research this data on the Internet to compare.

**Explain** (45 minutes)

Students will read "What in the World is Happening to Our Climate?"

[https://www.globe.gov/documents/348830/35487706/EGclimate\\_Final\\_27April2017.pdf/64cdfb](https://www.globe.gov/documents/348830/35487706/EGclimate_Final_27April2017.pdf/64cdfb)

[a2-ce9f-4660-a4b5-0644c3f0be74](https://www.youtube.com/watch?v=a2-ce9f-4660-a4b5-0644c3f0be74). Students will watch the following

video--<https://youtu.be/nAuv1R34BHA?list=PL9TFrgFq7555f>

Formative Assessment Discussion Questions:

How many degrees has Earth's temperature risen in the last century?

How do greenhouse gases in the atmosphere contribute to higher temperatures on Earth?

How does melting ice contribute to higher temperatures on Earth?

Is this video an example of climate or weather? Why?

What do you predict will happen to Earth's average temperature in 100 years?

Using a science journal/notebook, students will create a Circle Thinking Map. Students will place the words "Earth's Climate" in the center of the circle then brainstorm ideas showing knowledge about that topic. Students may share and discuss responses with a partner or in small groups.

**Elaborate** (45 minutes)

Students will learn about houses around the world by reading the article and viewing the video

on the following website-- <http://www.kidcyber.com.au/houses-around-the-world/>.

Formative Assessment Discussion Questions:

What does the roof of your house look like?

Do you know what your roof is made of?

Do you think people who live in tropical areas or desert areas have the same type of roof as you do?

Do you think the materials that are used are the same in different climates?

Introduce the TeachEngineering.org activity (Center for Engineering Education Outreach, 2013).

Students will choose materials and tools to create model houses for certain climates. The source of this material is the *TeachEngineering.org* digital library collection at

[www.TeachEngineering.org](http://www.TeachEngineering.org). All rights reserved.

Show students a wide range of photographs of houses around the world. Follow with a brief class discussion.

1. Discuss climate and weather conditions of various world regions. Identify the regions discussed on a globe or world map.
2. Discuss how the homes are constructed in each region.
3. Discuss the appropriate materials necessary to survive under the given climate and environmental conditions of a particular region.

Have teams of two-four students choose one of the following biomes for which they will construct a model home: desert, tropics or Arctic. Explain that teams will build a 10 x 10 x 10 cm model house with a roof designed to withstand the climate for their biome.

Explain (and post in the classroom) the goals for their house.

Desert climate – Should be able to keep an ice cube from melting. Place an ice cube in the center of the model house and expose the roof to wind and heat from a blow dryer for a specified amount of time (1-2 minutes). If the ice cube does not melt, then the roof can withstand the elements of heat and wind.

- Arctic climate – Should be able to support snow. Gradually add coins or washers to the roof to determine if the roof can withstand a large amount of weight from snow. The house should be able to support a specified number (+/-10) of washers or coins to pass a "snow load" test.

- Tropics – Should be waterproof. Place the house on a platform in an empty pan and pour water through a strainer to simulate rain. Place dry tissue or other absorbent material in the house first to determine if the house leaks in the "rain." To pass the test, the roof must not collapse or leak. Use a standard amount of water (1-2 liters).

Students will work through the Ask, Imagine, Design a Plan, and Write a Plan sections on the Engineering Design Process activity sheet.

### **Engineer** (Two 45-minute lessons)

Teams will work through the Create, Improve, Communicate, and Reflect sections on the activity sheet. Remind students their house must be a 10 x 10 x 10 cm structure.

After all the model houses are completed, each group will present their house to the class. The class may ask questions regarding each group's house. The teacher will measure (10 x 10 x 10 cm) and test each house. As a class, discuss the results and encourage students to offer suggestions as to how each house could be improved. Remember to consider both materials and structural design (for example, roof angles) for the respective regions.

After the initial assessment of the houses, ask teams to list three positive and three negative aspects of their houses. Mention that this is a typical part of the engineering design process (analyze test results and improve the design). Each team should collaboratively decide (and list) how they would improve their house if they were given the opportunity and how they would construct another (better) model for that region. Students can create a Google Slide to share the information with the class.

Then, have each group trade their house with another group who will list other adjustments they think should be made in the design or construction of the house. Groups will share what they think should be fixed and why they would make the changes. Give teams time to redesign their homes and construct revised models. Test the second models, using the same criteria as the first.

### **Evaluate** (45 minutes)

Students will discuss the differences between weather and climate. Students will review how weather and climate affect our daily lives such as houses and clothing. Students will predict how climate change may affect our lives in the future. The teacher can evaluate comprehension using each student's Circle Map. The teacher can assess learning as students work through the

Engineering Design Process activity sheet to research, brainstorm, design, build, improve, and reflect. A rubric will be used to assess the students during the engineering design project. The students may use this rubric for self-assessment, and the teacher may use it for grading purposes.

### **Adjustments/Adaptations**

A KLEWS chart can be used throughout the lesson to reinforce concepts being taught. Students will work in small cooperative groups throughout the lesson. Each group member can choose a job card so that everyone is responsible for the group projects. Students will partner read the eBook and article. Discussion questions are based on different levels of Bloom's Taxonomy.

Groups are given choices in the Engineering portion of the lesson. The lesson considers different learning styles—visual, auditory, and kinesthetic.

### **Resources and Materials Needed**

Students will need: What in the World Is Happening with Our Climate?; Global Annual Mean Temperature Data; graph paper (four squares per inch); tape; scissors; science journal/notebook; photographs of roofs from houses around the world; Chromebooks; books about desert, tropical, and Arctic biomes; books with pictures of homes around the world; assortment of materials for students to create model homes which include--cardboard, poster board, foam core board, sticks, straws, wooden sticks, toothpicks, old cloth, foil, felt, straw, rocks, clay, wood, beans, Play-Doh, string, duct tape, paper clips, mosaic tiles, etc.; various roofing material which include--cardboard, clay for adobe houses, hay or long grass for grass huts, corkboard, saran wrap for roof for tropics houses, etc.; tape measures and rulers; water, strainer; ice cubes; hair dryer to produce wind; 10+ coins or washers; tissues; and plastic tub.

### **Links**

<https://www.nasa.gov/feature/goddard/2018/nasa-measures-heavy-us-rainfall-from-space>

<https://www.jpl.nasa.gov/edu/teach/activity/graphing-global-temperature-trends/>

[https://www.jpl.nasa.gov/edu/pdfs/global\\_annual\\_mean\\_temp\\_anomalies\\_land-ocean\\_1880-2016.txt](https://www.jpl.nasa.gov/edu/pdfs/global_annual_mean_temp_anomalies_land-ocean_1880-2016.txt)

[https://www.globe.gov/documents/348830/35487706/EGclimate\\_Final\\_27April2017.pdf/64cdfba2-ce9f-4660-a4b5-0644c3f0be74](https://www.globe.gov/documents/348830/35487706/EGclimate_Final_27April2017.pdf/64cdfba2-ce9f-4660-a4b5-0644c3f0be74)

<https://youtu.be/nAuv1R34BHA?list=PL9TFrgFq7555f>

<http://www.kidcyber.com.au/houses-around-the-world/>

<http://cedar-wmu.edenpr.org/rrice/files/2012/03/Thinking-Map-Templates.pdf>

[https://www.teachengineering.org/activities/view/roofs\\_for\\_different\\_climates](https://www.teachengineering.org/activities/view/roofs_for_different_climates)

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- Texas Education Agency. (2017a). Texas essential knowledge and skills for 5<sup>th</sup> grade. §110.15. English Language Arts and Reading. <http://tea.texas.gov>
- Texas Education Agency. (2017b). Texas essential knowledge and skills for 5<sup>th</sup> grade. §112.15. Science. <http://tea.texas.gov>

## **Engineering Design Process Matrix**

### **Ask**

What is the problem? What does research say about this problem? What are your constraints?

### **Imagine**

What are some possible solutions to this problem? Brainstorm ideas.

### **Design a Plan**

Draw a model for solving the problem. Label the materials you will use to create your model.

### **Write the Plan**

Write the steps for creating the plan.

**Create**

Using your plan, make your model and test it. What worked? What didn't work? What changes need to be made?

**Improve**

How can you improve your model?

**Communicate**

Was your model successful? Why or why not?

**Reflect**

What did you learn from completing this engineering design activity?

**Engineering Design Process Rubric**

**Individual Progress Report**

Name \_\_\_\_\_

Date \_\_\_\_\_

Project \_\_\_\_\_

Grade \_\_\_\_\_

<b>Criteria</b>	<b>4-5 Points</b>	<b>2-3 Points</b>	<b>0-1 Points</b>	<b>Points</b>
<b>Identifying the problem and brainstorming solutions</b>	Shown a clear understanding of the problem(s) to solve. Independently brainstormed solutions.	Needed some teacher direction to define the problem(s) and brainstorm possible solutions.	Needed lots of teacher direction to define the problem(s). Little if any independent brainstorming.	
<b>Working as a team member</b>	Worked well with team members. Participated and stayed on task.	Was occasionally off task.	Was often off task and not cooperating or participating fully	
<b>Using the engineering design process</b>	Assisted team in brainstorming many design ideas. Actively participated in testing and improving the design.	Was occasionally off task instead of assisting team in brainstorming ideas, testing, and improving design.	Brainstormed few design ideas and did little testing or redesigning.	

Processing the science and engineering during group presentation	Assisted team in strong presentation of its solution to the challenge. Showed clear understanding of the science concepts and design process.	Was occasionally off task during presentation. Showed less than adequate understanding of the science concepts and design process.	Did not participate in presentation. Showed little understanding of the science concepts and design process.	
				<b>Total Points</b>

**KLEWS Chart**

<b>K</b>	<b>L</b>	<b>E</b>	<b>W</b>	<b>S</b>
What we think we know about the phenomenon	What we are learning	Evidence of learning (data)	Wonderings	Scientific concepts and words

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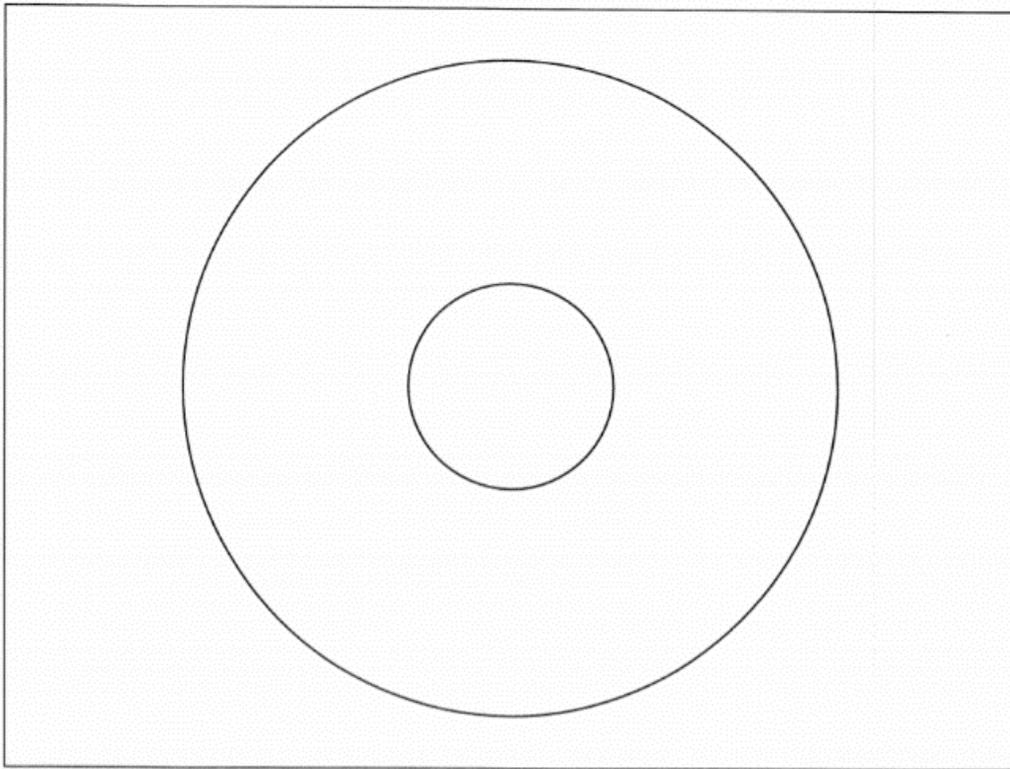
Retrieved from Zembal-Saul, McNeill, & Hershberger, 2012

**Job Cards**

<p style="text-align: center;"><b>Principal Administrator</b></p> <ul style="list-style-type: none"><li>• Reads the directions</li></ul>
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<ul style="list-style-type: none"> <li>• Ensures correct measurements</li> <li>• Keeps the team focused on the activity <ul style="list-style-type: none"> <li>• Checks the team's work</li> </ul> </li> </ul>
<p style="text-align: center;"><b>Construction Specialist</b></p> <ul style="list-style-type: none"> <li>• Follows the safety rules <ul style="list-style-type: none"> <li>• Directs the cleanup</li> </ul> </li> <li>• Ensures everyone is participating</li> <li>• Makes sure the prototype follows the design plan</li> </ul>
<p style="text-align: center;"><b>Material Resource Officer</b></p> <ul style="list-style-type: none"> <li>• Picks up and returns the materials</li> <li>• Ensures everyone takes a turn operating or using the equipment <ul style="list-style-type: none"> <li>• Reports the team's questions to the teacher</li> <li>• Assures materials are cut correctly</li> </ul> </li> </ul>
<p style="text-align: center;"><b>Engineering Supervisor</b></p> <ul style="list-style-type: none"> <li>• Collects and records observations and results</li> <li>• Leads discussions regarding the team's results <ul style="list-style-type: none"> <li>• Tests the team's prototype</li> <li>• Explains the results to the class</li> </ul> </li> </ul>

**Circle Thinking Map**



**Circle Map for Defining in Context • Frame for Frame of Reference**

Retrieved from <http://cedar-wmu.edenpr.org/rice/files/2012/03/Thinking-Map-Templates.pdf>

Appendix G

**Names and Telephone Numbers of Five Participating Teachers**

1. Dr. Betty Crocker—(940)999-0065
2. Wendy Kennedy—(817)905-4255
3. Elaine Rose—(469)831-6762
4. Rachelle Stephenson—(972)743—6993
5. Debra Hardy—(940)482-2601 Work number at Krum High School