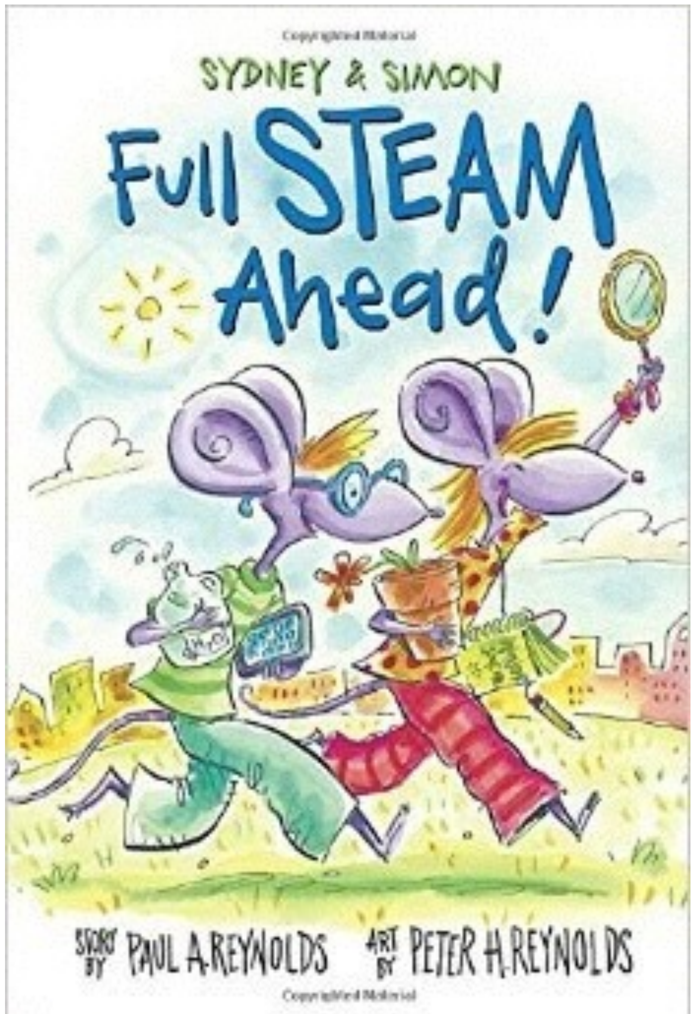
Full STEAM Ahead: Teaching the Engineer Design Process with Sydney & Simon



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Grades K-5: Teaching the Engineer Design Process with Sydney & Simon

Materials (Can be done whole class K-2 and groups 3-5)**:**

- Copies of Full STEAM Ahead
- SMARTboard, whiteboard, or chalkboard
- Google Drive or STEAM notebooks or chart paper
- Recyclable materials collected from home
- Glue, tape, scissors, yarn, etc.
- Students will decide other materials needed

Purpose

Students will understand the steps of the engineer design process by applying them to develop activities for Full STEAM Ahead.

Engage

Begin by discussing STEAM (science, technology, engineering, the arts, and math) with students. Continue the class discussion with the engineer design process (see Appendix F), explaining each step. Have students identify real world situations where people would use the process. Then tell students: Imagine being hired by the Reynolds brothers to create activities for teachers to use with Full STEAM Ahead. Present students with the problem: the book does not have activities to go along with the story to be used in classrooms. Students begin their adventure by meeting in small collaborative teams of 4-5, reading the story together once. Then meet whole class to go over important story elements. The story should be read whole class in K-2 classrooms, discussing each chapter, identifying the main idea and themes within the story. Write ideas down on the board.

Explore

Once students have had an opportunity to discuss the story they should return to their groups (or whole class) and reread the story, stopping where they think an activity could occur. In younger classrooms this should be done whole class or in small groups with parent volunteers. Students should brainstorm a list of activities and page numbers associated with them to be done with the story (see Appendix A) in the Google Drive, chart paper, or STEAM notebooks. Students discuss which is the best possible activity to design for teachers. They create a materials list of supplies needed to construct their activity, using primarily classroom items and recyclable materials.

Explain

Students design their lesson plan in the Google Drive or STEAM notebook. Depending on the grade level will depend on the components students put in their lesson plan. Students need to identify what learners should know and learn from their activity. All plans should have a purpose, materials and a procedure. In grade 5 students were introduced to Universal Design for Learning when creating their lessons. Students should explain their activity to an adult and what people will learn by conducting their activity and its connection to Full STEAM Ahead. Students use the Google Drive or STEAM notebooks to write out the purpose, materials, and procedure of the activity. They decide on a method to tell if student learning has occurred (See Appendix B).

Elaborate

Students create their activities, creating a model and testing it (See Appendix B and D). They must evaluate their model to see what else is needed for a teacher to successfully implement the activity in a classroom. Students make observations as they conduct their activity, describing the outcomes. Their responses should be supported by vocabulary from the engineer design process and Full STEAM Ahead story and documented.

Evaluate

Return to the image of the engineer design process. Ask students to think about their activity and explain how they used the process to create it. What happened when you tested your model? What improvements did you make? What would you do next? Ask students to explain their reasoning either in the Google Drive or STEAM notebook. After the discussion students then return to their groups to reflect together on the following questions: How did your group use the engineer design process to create your lesson? After testing out your lesson what worked well? Would you change anything? How does your activity relate to the book? How does it relate to STEAM? Why do you think teachers should use your activity? This authentic learning experience placed students in the role of the teacher while learning the steps of the engineer design process.

Appendix A: Developing Possible Solutions- ideas from 5th grade students

Group 1 (chosen activity bolded): Mark, Emily, Aadi, Cameron, and Steven

1. **Kids could plant flowers and observe their growth. pg.6**
2. Kids can do projects on water vapor.pg.15
3. You could find out ways to save water.pg.24
4. You could find out how much water in your sink can fill up a jar.pg.26
5. You find out how water gets from one place to another.pg.40
6. Make your own screw pump.pg.40
7. You could do a PowerPoint on photosynthesis. every page
8. How could you improve the hose to reach the flowers.pg.9
9. Make your own wonder journal.pg.10
10. Make some new words that are like steam.no page
11. Try to make a design for a smaller watering can. pg.23
12. Try to make an idea to stop the leaky faucet. pg.29

Group 2 (chosen activity bolded): Eagan, Jacob A., Jessica, and Sadie

1. Page-5-people can do a flower show
2. Page-7-people can make videos on how to take care of a flower
3. Page-9- kids can make up new words
4. **Page-13-can test experiments on flowers**
5. Page-18- before and after pictures of flowers after experiments
6. Page-35-kids can build miniature water water pumps
7. Page-6-Kids can manufacture flower boxes
8. Page-43-Study how flowers change over a long period of time
9. Page- 6-Kids can find out why windows get stuck in hot weather
10. Page-20-Make a project about the water cycle

Group 3 (chosen activity bolded): Brandon, Shivali, Keighley, and Owen

1. plant your own flower then draw and label the parts pg.7
2. cut a paper flower then reassemble it pg.7
3. make your own method to water a flower pg.9
4. journal your flowers growth pattern pg.9
5. draw a picture of a flower that you grew pg.7
6. make a prediction of the flower you grew pg.12
7. you can see why windows stick in hot weather pg.13
8. find ways to open a stuck window with S.T.E.A.M. PG.13
9. find out what water vapor is and how it is created pg.14
10. write a poem about a flower pg.15

11. do a before and after scene about a plants growth pg.17

12. do an experiment and draw the water cycle pg.20

13. make your own water system out of straws pg.32

Group 4 (chosen activity bolded): Liam, Tess, Thomas, Regan, and Will

1. Share and draw flowers Pg.7
2. grow two flowers, one in a box and one out in the open Pg.8
3. fill a jar with water and dirt and put it out in the sun Pg.18
4. **describe the water cycle Pg.20**
5. describe the connections among you Pg.24
6. estimate the amount of water droplets it takes to fill a jug Pg.25
7. find a way to transport water from one room to another without a bucket Pg.32
8. write a poem about science Pg.41
9. make a dance to that goes with the sound of rain Pg.44

Group 5 (chosen activity bolded): Baylee, Sam, Camden, and Sierra

1. Pg.6 Make a window box for flowers.
2. Pg.7 Make a plan to get water through a window on the third story.
3. Pg.12 Make a journal.
4. Pg.13 Make an invention.
5. Pg.17 Fill a jar with water and dirt and record the changes.
6. Pg.20 Show the water cycle.
7. Pg.21 Draw a pipe that brings water from one place to another that doesn’t leak.
8. Pg.37 Design a pump.

9. **Pg.40 Make a pump.**

10. Pg.43 Have your own flower show.

Appendix B: Plan, Create, and Test- Lesson plans from real kids:

Kid Tested Kid Approved

Group 1: Mark, Emily, Aadi, Cameron, and Steven

Flower Power!

Purpose: We want students to learn that there are better places to grow plants.

Materials	Plant Seeds	Pots (You can use used pots, recycled water bottles, or plain plastic cups)	Water	Space with plenty of sunlight	Place with little sunlight

Procedure:

- Plant the seeds with soil in a cup or buy plants from a store.

- First you write a prediction on a note card. Students should predict which one will grow the fastest. One set of plants is going in a location that is dark and has little water. Another group of plants is going in the dark and has lots of water. A third group of plants is going in the sun with little water. The last group is going in the sun with lots of water.
- After that you chart the growth and send it to your teacher. We watered the plants that needed water once a day.
- Create a table like the example below to track the growth:

Day after first growth	1	2	3	4
Plant A	1 inch	1 ½ inch	2 inches	2 ½ inches
Plant B	1 inch	2 inches	2 inches	2 ½ inches
Plant C	1/30 of an inch	1 inch	1 ½ inches	2 inches
Plant D	1 inch	2 ½ inches	3 inches	4 inches

Assessment: Students should answer these on paper or in their Google Drive.

1. Which plant grew the tallest and the fastest?
2. Why do you think that is?
3. Which plant grew the least and the slowest?
4. Why do you think this is?
5. What did you learn in the process of this experiment?

Group 2: Eagan, Jacob A., Jessica, and Sadie

Flower Experiment

Purpose: You will learn how flowers soak up the dyed water like they do to regular water. When they absorb it, the pigment of the white flower will change.

Materials:

~2 White flowers

~water

~vase

~food coloring (any color)

What to do:

Pour the water into the vase. Pour two drops of any color of the food coloring into the vase.You can put any number of drops and colors into the vase . Next you would put the flowers into the vase. After you do this predict which flower will absorb more color and predict which one will absorb the food coloring first. This will take at least 3-5 days.

Assessment: Students will fill out a lab sheet to show that they understand this lesson.

Lab Sheet

Name:________________________________ Date:__________

What flower do you think will absorb the dye faster?

____

____

What flower will absorb more dye?

____

____

Can you guess the number of hours it will take to absorb the dye?

____

____

Do you think it matters if the flower or water gets sun?

____

____

Do you think the color in the flower will last forever?

Do you think the color will affect the flower's life span?

Without the stem do you think it would still absorb it, "if you just put the flower in the colored water?"

Group 3: Brandon, Shivali, Keighley, and Owen

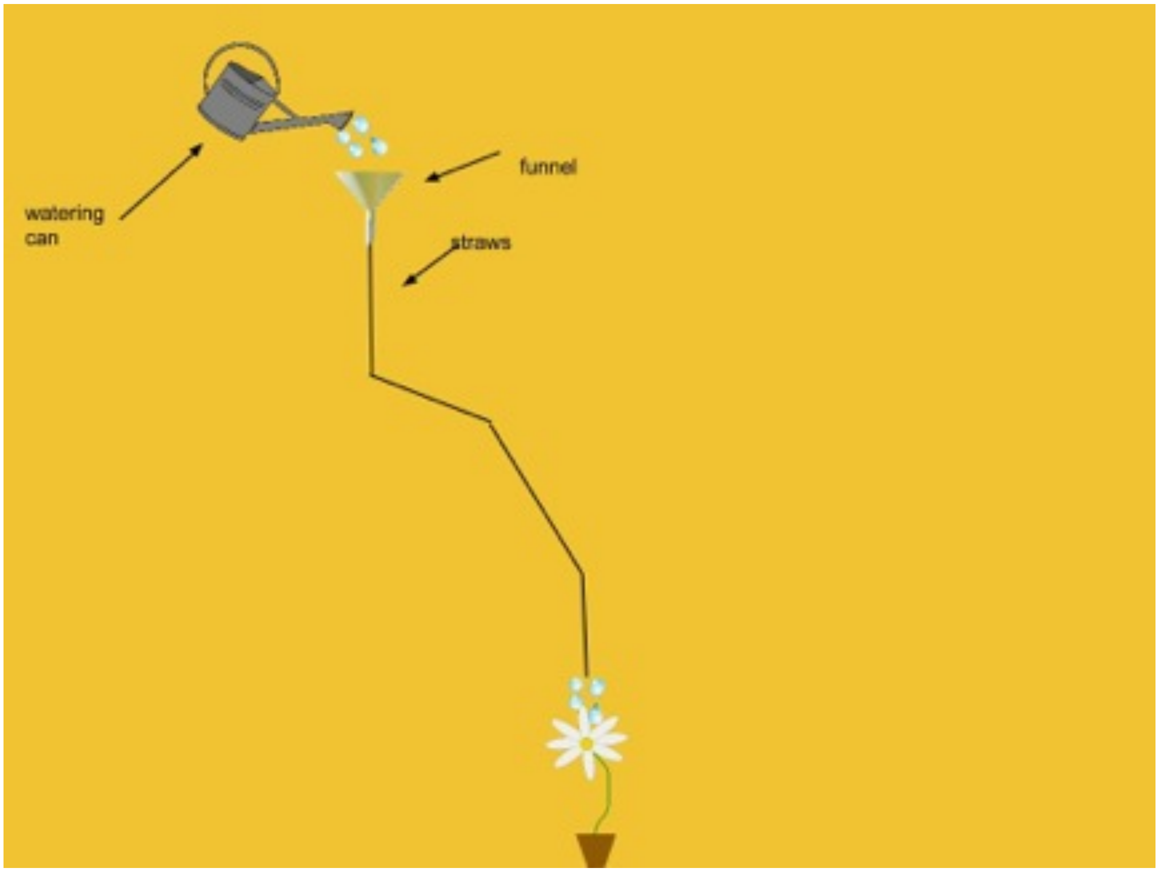
Activity Name: Make Your Own Water System?

Purpose: How to make your own water system with straws in order to water your own plants.

Material List: straws, tape, water, funnel, cup of water

Procedure: You take the straws and tape them so the open holes are inside one another until it is a long tube, and then you can bend it however you want to then tip water through the straw tubes and you got your own water system. Then you test the activity out. Make sure water goes through the system and into the flower pot

Assessment: Write what you learned and the results of your project. Did the flower grow and how much? Record your progress and present your water system your the class telling them what you learned about your project.



Group 4: Liam, Tess, Thomas, Regan, and Will

Water cycle movement

Purpose:

The purpose for our idea is to teach kids about how the water cycle works, and what the steps are. The reason we chose this idea was because we thought it would be the most effective for kids to learn and remember.

Materials:

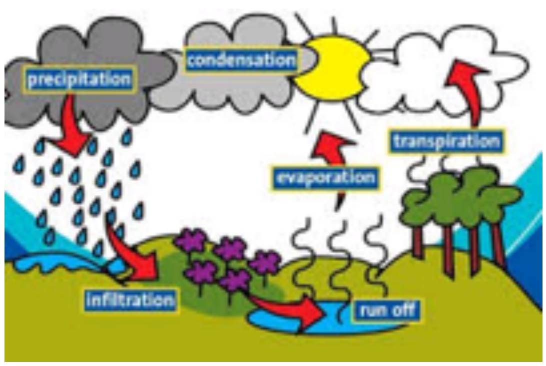
- notecards
- pencils
- computers(optional)

Procedure:

Make 5 groups of however many people needed. Give each group one step in the water cycle (Condensation, Precipitation, Evaporation, Transpiration, Infiltration). The groups should write a summary about their step in the water cycle, including what the step does for the water cycle and how it happens. Each group should make up movements that goes along with their summary of their step in the water cycle. They should present their summary along with their movements in front of the other groups(do it in the order of the water cycle). Finally you can use a computer to look up facts about the water cycle if needed.

Assessment:

To see what the students have learned you should, have them write what they learned on a note card. They should do this when they are done with the procedure.



Group 5: Baylee, Sam, Camden, and Sierra

Make a pump

Purpose: The purpose of this lesson is to teach kids the engineer design process and S.T.E.A.M. by making a pump to water flowers.

Materials: Recycled materials, tape and plastic wrap.

Procedure:

1. Get supplies.

2. Make blueprints for the pump. Sketch the several pump designs. It needs to go from a water source to a flower box.

3. Agree on the best design.

4. Plan the pump.

5. Build the pump.

6. Test the pump.

7. Find problems with the pump.

8. Repeat 6-8 until your pump is as good as possible.

Assessment: For the assessment you have to explain how you used the engineer design process.

Appendix C: Reflections from 5th grade students

Group 1: Mark, Emily, Aadi, Cameron, and Steven

1. Did your group use the engineer design process to create your lesson?
    a. We used the engineer design process in our project by identifying our problem, which were the children in STEAM not being able to water their plants. Then we brainstormed, re-designed. Next we deleted and added stuff so we could help students learn new things.
2. After testing out your lesson what worked well? Would you change anything?

    a. The sunlight and lots of water worked well with the experiment. So did the less water and lots of shade. We would change the amount of water we used for the lot of water, because we feel there was too much.
3. How does your activity tie to the book? How does it relate to STEAM?
    a. Our activity tied to the book because in the book because in the book they were doing different experiments including flowers, and our experiment is to see how flowers best grow.
4. Why do you think teachers should use your activity
    a. They should use our activity because it is a fun way to teach kids about the conditions that a flower needs to grow.

Group 2: Eagan, Jacob A., Jessica, and Sadie

1. How did your group use the engineer design process to create your lesson?
    a. We had to keep trying different solutions for our flower experiment until it would work.
2. After testing out your lesson what worked well? Would you change anything?
    a. The dyed water went up the paper. We would've used a flower.
3. How does your activity relate to the book? How does it relate to STEAM?
    a. It relates to steam because we do an experiment that has something to do with flowers and water.
4. Why do you think teachers should use your activity?
    a. Because it could teach them how flowers suck up water through their stems and it's very fun.

Group 3: Brandon, Shivali, Keighley, and Owen

1. How did your group use the engineer design process to create your lesson?
    a. We used the process by building a model finding and solving a problem too.
2. After testing out your lesson what worked out well? Would you change anything?
    a. The water travels well in the model
3. How does your activity tie to the book? How does t relate to STEAM?
    a. It ties to the book because it solves the problem in the book.
4. Why do you think teachers should use your activity?
    a. Teachers should use this because students can learn the engineer design process in a fun way.

Group 4: Liam, Tess, Thomas, Regan, and Will

1. How did your group use the engineer design process to create your lesson?
    a. The need is that we needed to find a way to teach kids about the water cycle in a fun way that will hopefully appeal to the students. We came up with ideas with bulleted points. We chose an idea that would be fun and simple for students of all ages. We worked as a group to communicate and share ideas with each other. For step five we all decided to try our idea out so that we knew that it made sense. We didn't have to fix anything in the final design of our idea.
2. After testing out your lesson what worked well? Would you change anything?

a. Interacting worked well because it made the students think of something to do for a movement. However we wouldn't change anything with our activity.

3. How does your activity tie to the book? How does it relate to STEAM?
    a. Our activity ties to the book because it involves the water cycle like the book did. Also it relates to STEAM because science has to do with the water cycle.
4. Why do you think teachers should use your activity?
    a. We think teachers should use this activity because it will teach their students about the water cycle in a fun and creative way.

Group 5: Baylee, Sam, Camden, and Sierra

1. How did your group use the engineer design process to create your lesson?
    a. We did research in the book. Then we thought of a few answers. Then we tested them. After that we chose the best one and repeated the process.
2. After testing out your lesson what worked well? Would you change anything?
    a. The pipe to the sink worked well and we would not change anything.
3. How does your activity tie to the book? How does it relate to STEAM?
    a. It relates because the characters also made a pump and you use steam to make a pump.
4. Why do you think teachers should use your activity?
    a. They should use it because it is a group activity and it is a challenge but not to hard.

Appendix D

Photos of Students in Action

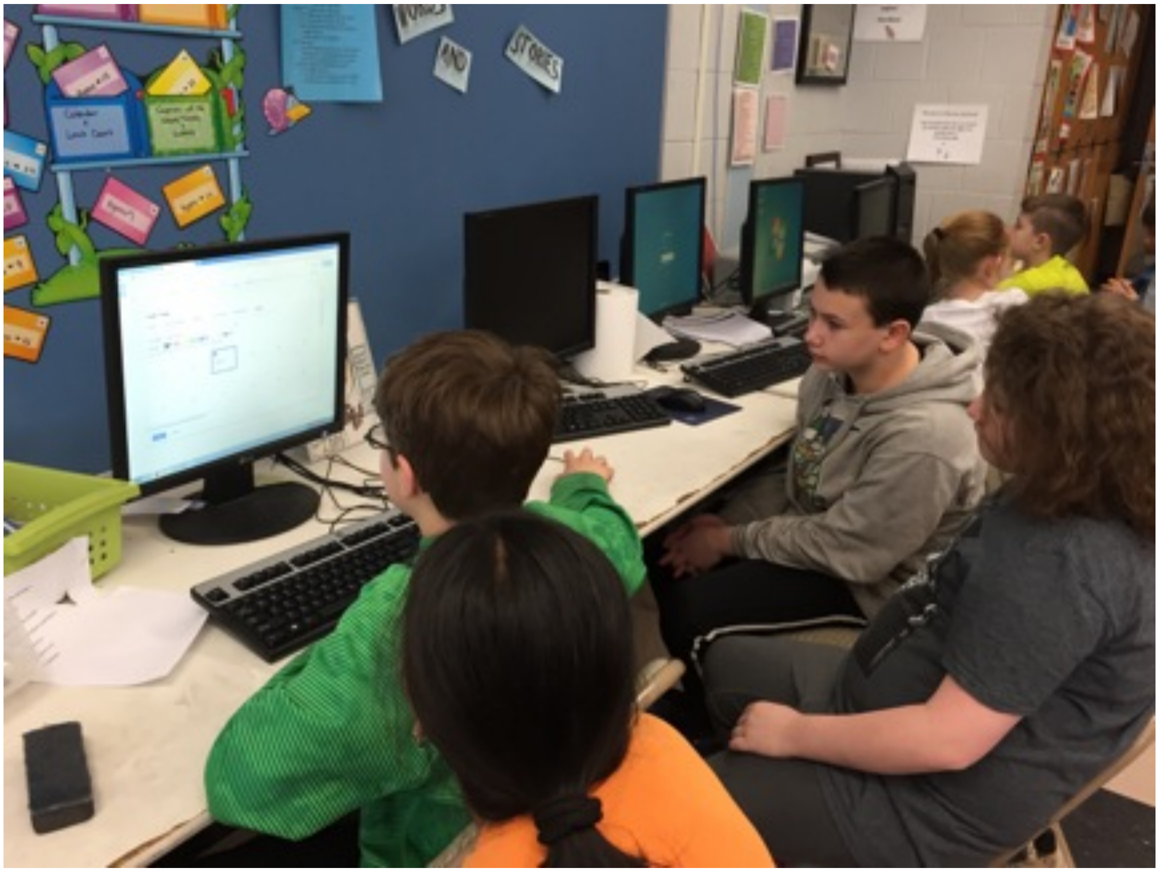
Students received copies of Full Steam Ahead

at the Blue Bunny Bookstore in Dedham, MA

(Back row) Paul Reynolds, Rayna Freedman, Peter Reynolds

(Front row) Jacob W., Thomas R., Jacob A.

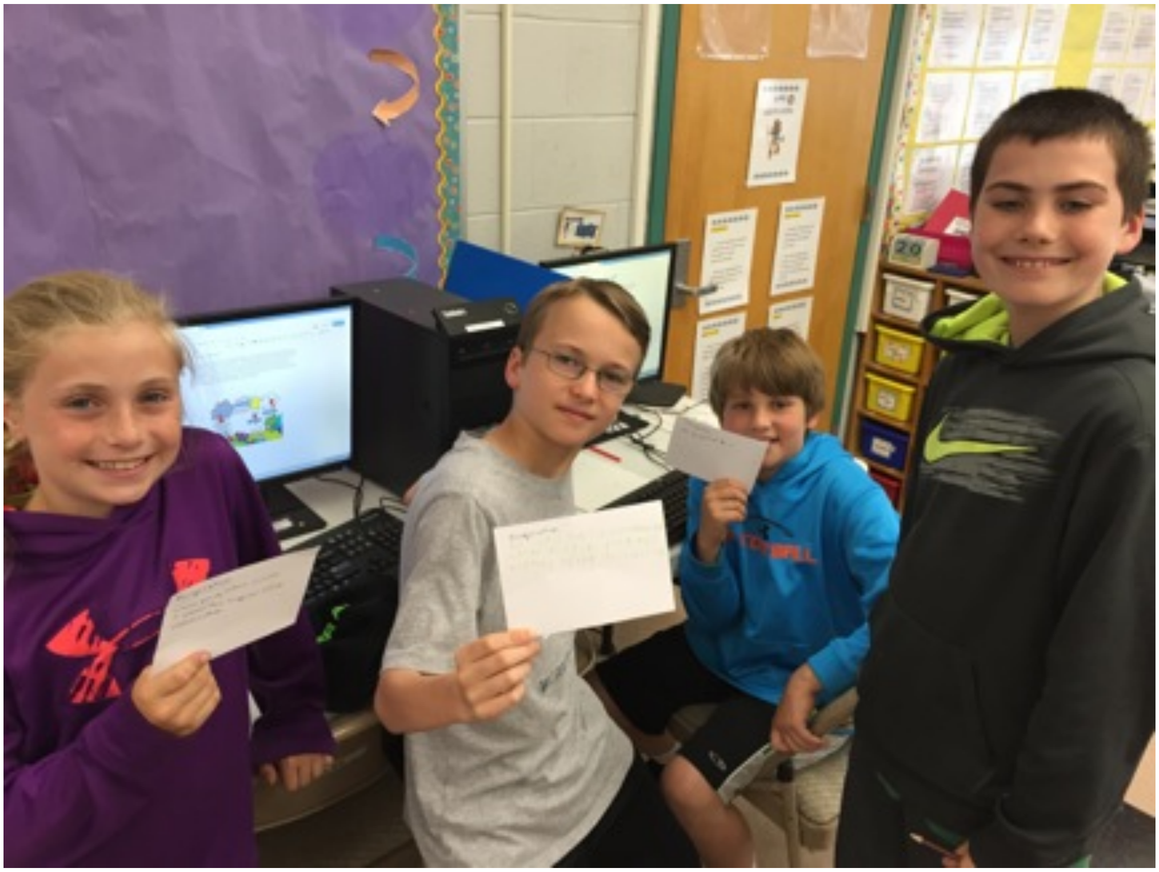
Mark D. and Emily G. exploring Full Steam Ahead, deciding where teachers could do activities with students.



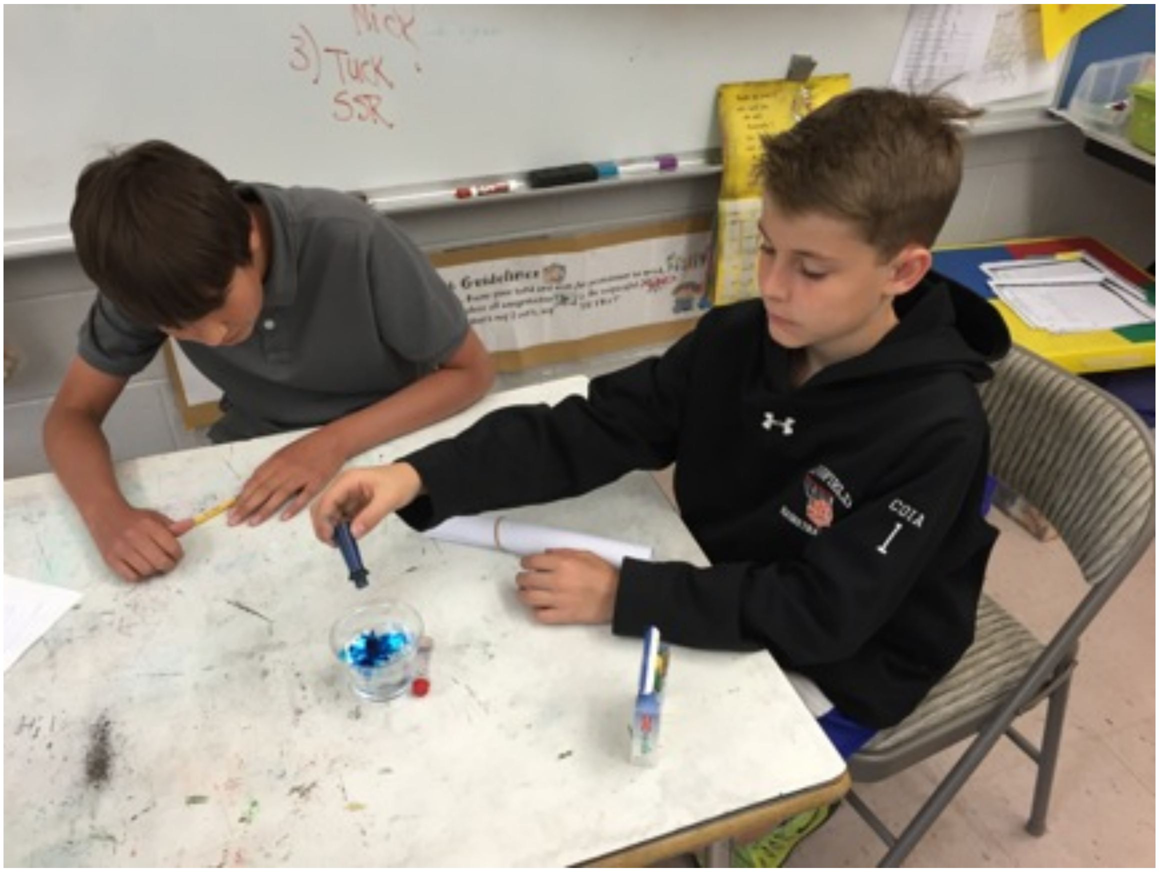
Shivali P., Brandon H., Keighley K., and Owen G. using the

Google Drive to create their lesson activities.

Mark D., Steven V., Aadi S., and Emily G. are getting ready to test out their activity!



Tess M., Thomas R., Liam C., and Will R. proudly show off their water cycle activity!



Jacob A. and Eagan C. begin to test their activity using food coloring, construction paper, water, and an elastic.

Keighley K. and Shivali P. show off their model of their irrigation system.

Appendix E

Connecting to NGSS

3-5 Engineering Design

Students who demonstrate understanding can:

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

Science and Engineering Practices:

Asking Questions and Defining Problems

Asking questions and defining problems in 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships.

- Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost. (3-5-ETS1-1)

Planning and Carrying Out Investigations

Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.

- Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (3-5-ETS1-3)

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.

- Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design problem. (3-5-ETS1-2)

Disciplinary Core Ideas

ETS1.A: Defining and Delimiting Engineering Problems

ETS1.B: Developing Possible Solutions

ETS1.C: Optimizing the Design Solution

Connecting to the Common Core

Common Core State Standards Connections:

ELA/Literacy –

RI.5.1

Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text.

(3-5-ETS1-2)

RI.5.7

Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently.

(3-5-ETS1-2)

RI.5.9

Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. (3-5-ETS1-2)

W.5.7

Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (3-5-ETS1-1),(3-5-ETS1-3)

W.5.8

Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. (3-5-ETS1-1),(3-5-ETS1-3)

W.5.9

Draw evidence from literary or informational texts to support analysis, reflection, and research.

(3-5-ETS1-1),(3-5-ETS1-3)

Mathematics –

MP.2

Reason abstractly and quantitatively.

(3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3)

MP.4

Model with mathematics.

(3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3)

MP.5

Use appropriate tools strategically.

(3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3)

3-5.OA

Operations and Algebraic Thinking

(3-5-ETS1-1),(3-5-ETS1-2)

References

National Governors Association center for Best Practices and Council of Chief State School Officers (NGAC and CCSSO). 2010. *Common core state standards.* Washington DC: NGAC and CCSO.

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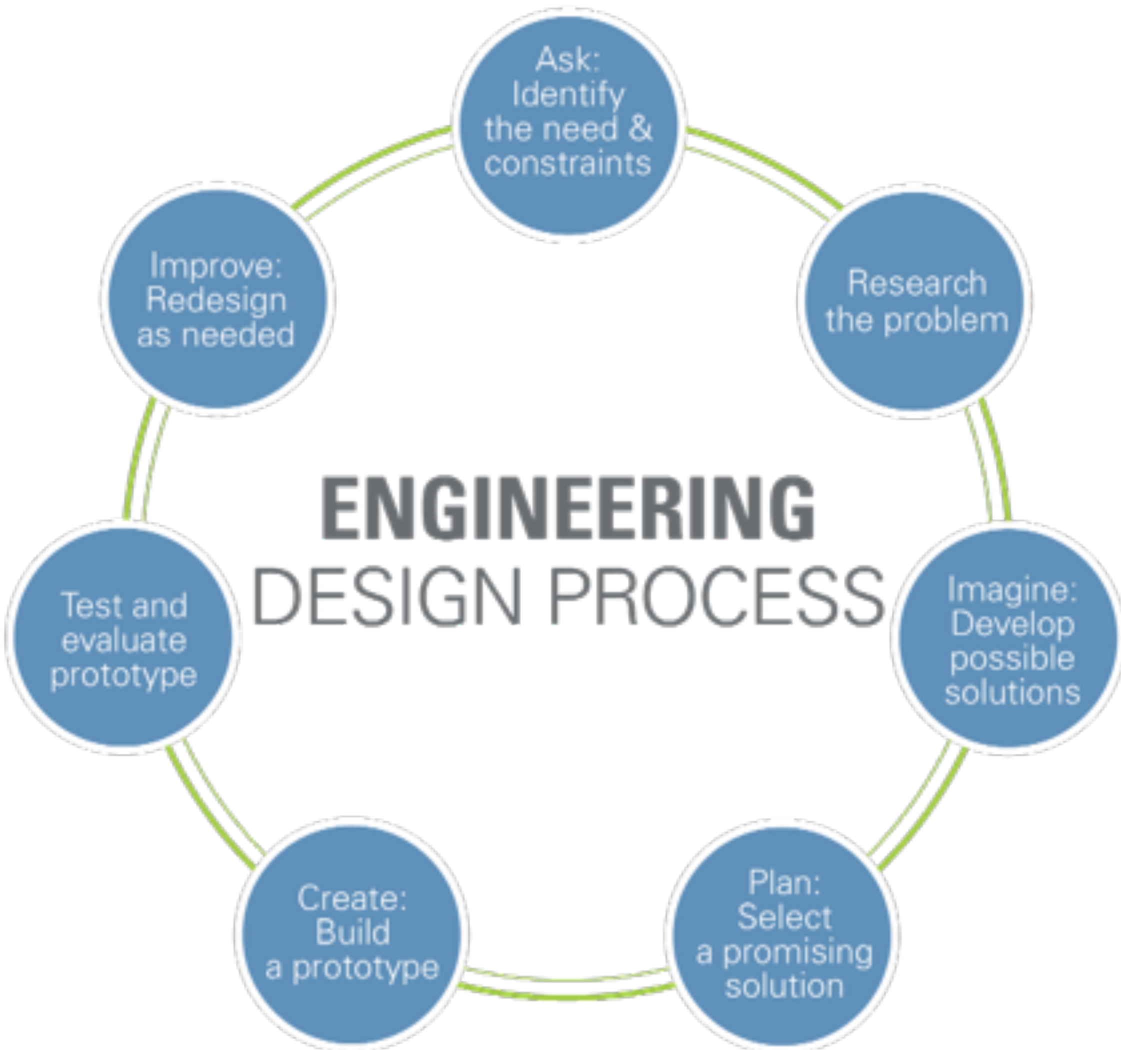
Appendix F



https://www.teachengineering.org/engrdesignprocess.php