Making the Grade

Unit: Henry as Innovator
Topic: Engineering

Thoreau Quotation

"Which would have advanced the most at the end of a month, — the boy who had made his own jackknife from the ore which he had dug and smelted, reading as much as would be necessary for this, — or the boy who had attended the lectures on metallurgy at the Institute in the mean while, and had received a Rodgers' penknife from his father?"

—"Economy", *Walden* (1854)

Background

Many people know Thoreau only as an author and an advocate for Nature. However, Thoreau was also a skilled engineer and was, in fact, instrumental in the improvement of the pencil! Thoreau developed a method that made manufacturing pencils a lot simpler and allowed them to be graded in terms of the hardness or softness of the lead. Technology is any mechanism or product that solves a problem or makes a task easier and Thoreau was able to design a pencil that was smear-free and that did not break easily.

Objectives

1. Brainstorm problems students encounter using everyday objects and create solutions for their problem.
2. To apply creative thinking and other skills such as math and simple research to come up with solutions to a problem.
3. Students will also learn about design constraints and how they impact an end product.

Method

Students will create solutions to common everyday problems in the classroom.

Time Required

75 minutes

Materials

- Pencils and/or pens
- Journals

- A wide variety of materials for improving the everyday object, such as string, tape, paper, scissors, glue, cardboard, pipe cleaners, popsicle sticks, paper clips, foam, anything from the recycling bin, etc.

Procedure

1. Brainstorm with students about problems that they have had with using everyday objects in the classroom or other features that they wish that their everyday objects possessed. Record all possible everyday objects and any issues they've had using each object on the board or piece of chart paper.
2. Break the class into small groups based on the problem they would like to solve.
3. Present the challenge: Your job is to solve the issue that you have selected. You should brainstorm as many designs as possible but you will have 45 minutes to develop, build, and come up with a way to present your improved object to the class. (Alternatively, if they need to bring an object from home with them or if materials for building the object need to be obtained from outside of the classroom, the brainstorming could be done one day in class and the creation of the solution could be done a following day.)
4. Before setting off to accomplish the challenge, students should discuss design limitations. This includes cost, availability of materials, time, space, and safety aspects.
5. Students are encouraged to employ a trial-and-error approach to solutions; coming up with ideas for solutions, trying it out and tweaking the idea—or starting over—based on the results of the trial.
6. At the end of the 45-minute time frame, students will share about their improved object.

Reflect and Explain

- Ask students what they learned during their investigation. What did they learn during the design process? What surprised them about their tests/trials? What would they do differently the next time they did this investigation? Did any new problems emerge with the design of their new object?
- Ask the students what materials from outside the classroom might have helped make their design better? How would have their design changed if there was no limit to the cost of the object or if there had been no time limit on the design process?
- Did you find it easy to come up with designs or was that hard? How did you pick the design that you chose (experimentation, group leader, was there conflict/cooperation)?

Extensions

1. Create persuasive ads (print or video) designed to sell their improved design.
2. Have each team member make an improved object based upon their group's design and use it for a day. How well did it work? What new problems arose? What old

problems still existed? How would they change their design now that they have used the new design?

3. Have each group write out the instructions for building their design and then have other teams build a different group's object. Were they able to understand the instructions? Was it easier or harder to follow instructions or come up with your own design?

4. Have each group improve the same everyday object. Then have every student or group add all of the other designs to their own object. What happens when the groups design in isolation and then they try to add all improvements to a single object?

Vocabulary

engineering – the work of designing and creating new products or systems by using scientific methods.

technology – anything that solves a problem or makes a task easier.

trial – a test to assess the effectiveness or performance of something (particularly a new product)

Additional Resources

Video on engineering careers https://www.youtube.com/watch?v=owHF9iLyxic

Video introduction to engineering http://nationalgeographic.org/media/nasa-kids-intro-engineering/

Common Core Standards

English Language Anchor Standards (all grades)

- CCSS.ELA-LITERACY.CCRA.SL.1
  Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.
- CCSS.ELA-LITERACY.CCRA.SL.4
  Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.
- CCSS.ELA-LITERACY.CCRA.SL.6
  Adapt speech to a variety of contexts and communicative tasks, demonstrating command of formal English when indicated or appropriate.
- CCSS.ELA-LITERACY.CCRA.L.1
  Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

- CCSS.ELA-LITERACY.CCRA.L.3
  Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend more fully when reading or listening.
- CCSS.ELA-LITERACY.CCRA.L.6
  Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when encountering an unknown term important to comprehension or expression.

Math Practice Standards (all grades)

- CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them.
- CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively.
- CCSS.MATH.PRACTICE.MP4 Model with mathematics.
- CCSS.MATH.PRACTICE.MP5 Use appropriate tools strategically.
- CCSS.MATH.PRACTICE.MP6 Attend to precision.