Module 4 Checkpoint - Revised

Summary: This is a unit plan for an engineering design process to be placed at the end of the Bonding Unit. Linked for each Engineering Design lesson is also the hyperdoc that I'll be using for it so in case we are remote, students can still follow along. The goal for this artifact would be to provide an outline for what lessons would look like for the end of this periodic table unit and to provide a starting point for how the lessons could look (via the linked hyperdocs). From there, we'll either modify some of these lessons, or deliver them directly to students as a first-year try-out, and then we'll hopefully get the chance to reflect on them at the end and see what did and did not work.

Target Audience: The target audience for this unit plan is my fellow 8th grade teachers (the unit plan) and our students (the lesson plans). My fellow teachers have taught this unit before, but they might need to know a bit of background about the NEA and the Grand Challenges that they present. We might also need to talk about what should get cut from other units to make room for this full project. This resource (a unit plan) is appropriate for this audience, because they are used to seeing these from me and this helps to provide the bigger picture as to what we are going to be doing and what the goal is for each day. The lesson plans, on the other hand, are created for the students, and they follow a hyperdoc format, which many students at my school have used before. These are tailored to 8th graders, so they provide guidance, but they also leave a lot of room for brainstorming and critical thinking.

Rationale: The reason that I chose to do it this way was so that when I present this to my colleagues, I have both the overall plan, but also the specifics of what they day to day will look like. As this will be the first time in the school year 8th grade students will be doing an engineering design-based project, students (and teachers) will need a lot of guidance, which is why the lessons are broken up the way that they are. Furthermore, these lessons are created so that in the beginning, there is a little introduction, and then they are mostly student-paced so that students can speed up and slow down as they need to.

Resources used to implement this artifact:

1. Computers/iPads (to view it)
2. Tinkercad (a program for students who want to 3D print their products)
3. Rubber gloves
4. Glass jars (jelly or canning jars work well)
5. 25 pennies, euros, or any other coin with copper coating
6. Salt
7. White/clear vinegar
8. Lemon juice
9. Orange juice
10. Baking soda
11. Scouring pad
12. Water
13. Water source
14. Bucket or sink area
15. Hundreds of dirty pennies, euros or other coins or materials with a high copper surface content

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8th grade: Engineering Design Mini-Unit

1. **Engineering Design Process Part 1**
    a. Goals:
        i. Introduce students to the engineering design process
    b. Specific Tasks:
        i. Outlined on this hyperdoc for the lesson
    c. Differentiation:
        i. Students are working in groups so that they can bounce ideas off of each other
        ii. Students have a choice as to how they would like to do their journal
        iii. Lesson is broken down into segments so that students can more easily follow
        iv. Lesson is self-guided so that students can go at their own pace
        v. Image is included for whole engineering design process so that students know where they are
    d. Sources for this lesson:
        i. "Can You Copperplate?" *TryEngineering.org Powered by IEEE*, 8 June 2021, tryengineering.org/teacher/can-you-copperplate/#dig-deeper.
        ii. Moore, Roxanne. *Research Gate*, Jan. 2015, www.researchgate.net/figure/Engineering-Design-Process_fig1_283479826.
        iii. Newcomb, Tim. "These Are the 30 Most Impressive Bridges in the World." *Popular Mechanics*, Popular Mechanics, 30 Apr. 2021, www.popularmechanics.com/technology/infrastructure/g2383/the-worlds-most-impressive-bridges/.
        iv. "Shine Bright Like A....Penny!: STEM Activity." *Science Buddies*, Science Buddies, 28 Feb. 2021, www.sciencebuddies.org/stem-activities/shine-bright-like-apenny.
        v. TEDEducation. "One of the Most Epic Engineering Feats in History - Alex Gendler." *YouTube*, YouTube, 11 Feb. 2020, www.youtube.com/watch?v=dyckL6HuLRU.
        vi. TEDEducation. "How the World's Longest Underwater Tunnel Was Built - Alex Gendler." *YouTube*, YouTube, 30 Mar. 2020, www.youtube.com/watch?v=qNS2jj2w-GI.
2. **Engineering Design Process Part 2**
    a. Goals:
        i. Introduce students to the engineering design process
    b. Specific Tasks:
        i. Outlined on this hyperdoc for the lesson
    c. Differentiation:
        i. Students are working in groups so that they can bounce ideas off of each other
        ii. Students have a choice as to how they would like to do their journal
        iii. Lesson is broken down into segments so that students can more easily follow
        iv. Lesson is self-guided so that students can go at their own pace
        v. Image is included for whole engineering design process so that students know where they are
    d. Sources for this lesson:
        i. "Can You Copperplate?" *TryEngineering.org Powered by IEEE*, 8 June 2021, tryengineering.org/teacher/can-you-copperplate/#dig-deeper.
        ii. Moore, Roxanne. *Research Gate*, Jan. 2015, www.researchgate.net/figure/Engineering-Design-Process_fig1_283479826.
        iii. "Shine Bright Like A....Penny!: STEM Activity." *Science Buddies*, Science Buddies, 28 Feb. 2021, www.sciencebuddies.org/stem-activities/shine-bright-like-apenny.
3. **Identify**

a. Goals:
    i. Introduce students to what the nitrogen cycle is
    ii. Introduce the NEA Grand Challenges
    iii. Introduce the problem that we are going to be focusing on: managing the nitrogen cycle
b. Specific Tasks:
    i. Outlined on this hyperdoc for the lesson
c. Differentiation:
    i. Lesson is broken down into segments so that students can more easily follow
    ii. Lesson is self-guided so that students can go at their own pace
    iii. Students get a choice in the video and the image that they choose for the nitrogen cycle
    iv. Guiding questions are present for student who don't know where to start
d. Sources for this lesson:
    i. Moore, Roxanne. *Research Gate*, Jan. 2015, www.researchgate.net/figure/Engineering-Design-Process_fig1_283479826.
    ii. Grand Challenges - 14 Grand Challenges for Engineering, www.engineeringchallenges.org/challenges.aspx.

4. Understanding Part 1: Research

a. Goals:
    i. Research the nitrogen cycle and harvesting the nitrogen cycle to figure out what is already out there and what could possibly be developed
b. Specific Tasks:
    i. Outlined on this hyperdoc for the lesson
c. Differentiation:
    i. Lesson is broken down into segments so that students can more easily follow
    ii. Lesson is self-guided so that students can go at their own pace
    iii. Image is included for whole engineering design process so that students know where they are
    iv. Students have a choice as to which sources they use
    v. Guiding questions are present for student who don't know where to start
d. Sources for this lesson:
    i. Moore, Roxanne. *Research Gate*, Jan. 2015, www.researchgate.net/figure/Engineering-Design-Process_fig1_283479826.
    ii. Grand Challenges - 14 Grand Challenges for Engineering, www.engineeringchallenges.org/challenges.aspx.
    iii. "A-Z Databases." *LibGuides*, pds.libguides.com/az.php?a=all.

5. Understand Part 2: Research Continued

a. Goals:
    i. Students will continue researching the nitrogen cycle by comparing sources, sharing what they have already found, and then deepening their understanding
b. Specific Tasks:
    i. Outlined on this hyperdoc for the lesson
c. Differentiation:
    i. Lesson is broken down into segments so that students can more easily follow
    ii. Lesson is self-guided so that students can go at their own pace
    iii. Image is included for whole engineering design process so that students know where they are
    iv. Students have a choice as to which sources they use
    v. Guiding questions are present for student who don't know where to start
d. Sources for this lesson:

i. Moore, Roxanne. *Research Gate*, Jan. 2015, www.researchgate.net/figure/Engineering-Design-Process_fig1_283479826.
ii. Grand Challenges - 14 Grand Challenges for Engineering, www.engineeringchallenges.org/challenges.aspx.
iii. "A-Z Databases." *LibGuides*, pds.libguides.com/az.php?a=all.

6. **Interview an Expert**
   a. Goals:
      i. Interview an alumni expert to further clarify the nitrogen cycle and the grand challenge on harvesting the nitrogen cycle
   b. Specific Tasks:
      i. Outlined on this hyperdoc for the lesson
7. **Ideate**
   a. Goals:
      i. Come up with ideas for what the device could be and look like
   b. Specific Tasks:
      i. Outlined on this hyperdoc for the lesson
   c. Differentiation:
      i. Lesson is broken down into segments so that students can more easily follow
      ii. Lesson is self-guided so that students can go at their own pace
      iii. Image is included for whole engineering design process so that students know where they are
      iv. Guiding questions are present for student who don't know where to start
   d. Sources for this lesson:
      i. Moore, Roxanne. *Research Gate*, Jan. 2015, www.researchgate.net/figure/Engineering-Design-Process_fig1_283479826.
8. **Evaluate**
   a. Goals:
      i. Evaluate the models they came up with last class to determine which one would be best to create a prototype of
   b. Specific tasks
      i. Outlined on this hyperdoc for the lesson
   c. Differentiation
      i. Lesson is broken down into segments so that students can more easily follow
      ii. Lesson is self-guided so that students can go at their own pace
      iii. Image is included for whole engineering design process so that students know where they are
   d. Sources used for this lesson:
      i. Moore, Roxanne. *Research Gate*, Jan. 2015, www.researchgate.net/figure/Engineering-Design-Process_fig1_283479826.
9. **Tinkercad 101**
   a. Goals:
      i. Introduce students to TInkercad so that they can use it to build a computational model of their design
   b. Specific Tasks:
      i. Outlined on this hyperdoc for the lesson
   c. Differentiation:
      i. Lesson is broken down into segments so that students can more easily follow
      ii. Lesson is self-guided so that students can go at their own pace

iii. Students have a choice as to which introductory video to watch depending on how much experience they have

d. Sources for this Lesson:
   i. Tinkercad. “Welcome to Tinkercad!” *YouTube*, YouTube, 5 Sept. 2018, www.youtube.com/watch?v=LrU2zm_g7lE.
   ii. “Introduction to Tinkercad.” *YouTube*, YouTube, 25 Mar. 2020, www.youtube.com/watch?v=9hkbGngpGVk.
   iii. jjacobscom. “Introduction To TinkerCad.” *YouTube*, YouTube, 18 Feb. 2017, www.youtube.com/watch?v=LcEsHW-GN20.
   iv. nrhlibrary. “Introduction to TinkerCAD.” *YouTube*, YouTube, 10 Apr. 2020, www.youtube.com/watch?v=uCqxyweqQ1Q.
   v. “Learn How to Use Tinkercad.” *Tinkercad*, www.tinkercad.com/learn/project-gallery;collectionId=OPC41AJJKIKDWDV.

10. Tinkercad Part 2

a. Goals:
   i. Continue learning how to use TInkercad so that students can use it to build a computational model of their design
b. Specific Tasks:
   i. Outlined on this hyperdoc for the lesson
c. Differentiation:
   i. Lesson is broken down into segments so that students can more easily follow
   ii. Lesson is self-guided so that students can go at their own pace
   iii. Students have a choice as to which introductory video to watch depending on how much experience they have
d. Sources for this Lesson:
   i. “Learn to Design With Code Using Tinkercad Codeblocks: a Quick-Start Guide.” *Instructables*, Instructables, 21 July 2020, www.instructables.com/Learn-to-Design-With-Code-Using-Tinkercad-Codebloc/.
   ii. “Using Loops in Tinkercad to Design a Bursting Star.” *Instructables*, Instructables, 9 Jan. 2020, www.instructables.com/Using-Loops-in-Tinkercad-to-Design-a-Bursting-Star/.

11. Prototype Day 1

a. Goals:
   i. Begin to create the model of the device on Tinkercad
b. Specific Tasks:
   i. Outlined on this hyperdoc for the lesson
c. Differentiation:
   i. Lesson is broken down into segments so that students can more easily follow
   ii. Lesson is self-guided so that students can go at their own pace
   iii. Image is included for whole engineering design process so that students know where they are
   iv. Students can choose whether to use 3D designs or Codeblocks depending on their coding experience
d. Sources used for this lesson:
   i. Moore, Roxanne. *Research Gate*, Jan. 2015, www.researchgate.net/figure/Engineering-Design-Process_fig1_283479826.

12. Prototype Day 2

a. Goals:
   i. Finish creating the model of the device on Tinkercad and send the file to 3D print
b. Specific Tasks:

i. Outlined on this hyperdoc for the lesson

c. Differentiation:
   i. Lesson is broken down into segments so that students can more easily follow
   ii. Lesson is self-guided so that students can go at their own pace

13. Presentation Creation Day

a. Goals:
   i. Create a presentation that outlines the solution to the problem, as well as the engineering design process that was used to arrive there

b. Specific Tasks:
   i. Outlined on this hyperdoc for the lesson

c. Differentiation:
   i. Lesson is broken down into segments so that students can more easily follow
   ii. Lesson is self-guided so that students can go at their own pace
   iii. Image is included for whole engineering design process so that students know where they are

d. Sources used for this lesson:
   i. Moore, Roxanne. *Research Gate*, Jan. 2015, www.researchgate.net/figure/Engineering-Design-Process_fig1_283479826.
   ii. herrp8765. "7x7 Rule for PowerPoint." *YouTube*, YouTube, 24 Aug. 2013, www.youtube.com/watch?v=sWmzl0-KKHM.

14. Project Presentation Day

a. Goals:
   i. Present solutions to the class, give and receive feedback, and reflect on the engineering design process

b. Specific Tasks:
   i. Outlined on this hyperdoc for the lesson

c. Differentiation:
   i. Lesson is broken down into segments so that students can more easily follow
   ii. Lesson is self-guided so that students can go at their own pace

15. Reflection and Editing

a. Goals:
   i. Reflect on the feedback and edit presentation to create a final product

b. Specific tasks:
   i. Outlined on this hyperdoc for the lesson

c. Differentiation:
   i. Lesson is broken down into segments so that students can more easily follow
   ii. Lesson is self-guided so that students can go at their own pace

References:

1. "A-Z Databases." *LibGuides*, pds.libguides.com/az.php?a=all.
2. "Can You Copperplate?" *TryEngineering.org Powered by IEEE*, 8 June 2021, tryengineering.org/teacher/can-you-copperplate/#dig-deeper.
3. Educational Leadership. (2014). How STEM instruction should change. STEM for all, 72(4), 93–94. Retrieved fromhttp://www.ascd.org/publications/educationalleadership/dec14/vol72/num04/How-STEM-Instruction-Should-Change.aspx
4. Grand Challenges - 14 Grand Challenges for Engineering, www.engineeringchallenges.org/challenges.aspx.

5. herrp8765. “7x7 Rule for PowerPoint.” YouTube, YouTube, 24 Aug. 2013, www.youtube.com/watch?v=sWmzl0-KKHM.
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8. jjacobscom. “Introduction To TinkerCad.” *YouTube*, YouTube, 18 Feb. 2017, www.youtube.com/watch?v=LcEsHW-GN20.
9. Knowles Engineering Design Process Rubric: https://knowlesteachers.org/wp-content/uploads/2017/10/KnowlesEngineering_DesignProcessRubric.pdf
10. “Learn How to Use Tinkercad.” *Tinkercad*, www.tinkercad.com/learn/project-gallery;collectionId=OPC41AJJKIKDWDV.
11. “Learn to Design With Code Using Tinkercad Codeblocks: a Quick-Start Guide.” *Instructables*, Instructables, 21 July 2020, www.instructables.com/Learn-to-Design-With-Code-Using-Tinkercad-Codebloc/.
12. “Manage the Nitrogen Cycle.” Grand Challenges - Manage the Nitrogen Cycle, www.engineeringchallenges.org/9132.aspx.
13. Moore, Roxanne. *Research Gate*, Jan. 2015, www.researchgate.net/figure/Engineering-Design-Process_fig1_283479826.
14. Newcomb, Tim. “These Are the 30 Most Impressive Bridges in the World.” *Popular Mechanics*, Popular Mechanics, 30 Apr. 2021, www.popularmechanics.com/technology/infrastructure/g2383/the-worlds-most-impressive-bridges/.
15. nrhlibrary. “Introduction to TinkerCAD.” *YouTube*, YouTube, 10 Apr. 2020, www.youtube.com/watch?v=uCqxyweqQ1Q.
16. “Shine Bright Like A....Penny!: STEM Activity.” *Science Buddies*, Science Buddies, 28 Feb. 2021, www.sciencebuddies.org/stem-activities/shine-bright-like-apenny.
17. TEDEducation. “One of the Most Epic Engineering Feats in History - Alex Gendler.” *YouTube*, YouTube, 11 Feb. 2020, www.youtube.com/watch?v=dyckL6HuLRU.
18. TEDEducation. “How the World's Longest Underwater Tunnel Was Built - Alex Gendler.” *YouTube*, YouTube, 30 Mar. 2020, www.youtube.com/watch?v=qNS2jj2w-GI.
19. Tinkercad. “Welcome to Tinkercad!” *YouTube*, YouTube, 5 Sept. 2018, www.youtube.com/watch?v=LrU2zm_g7IE.
20. “Using Loops in Tinkercad to Design a Bursting Star.” *Instructables*, Instructables, 9 Jan. 2020, www.instructables.com/Using-Loops-in-Tinkercad-to-Design-a-Bursting-Star/.