8th Grade
Matter and Energy Science

Teaching the Science and Engineering Education (SEEd) Standards

UVU College of Engineering & Technology
UTAH VALLEY UNIVERSITY

UVU CREATIVE LEARNING STUDIO

UVU School of Education
UTAH VALLEY UNIVERSITY

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Ice Cube Experiment

Grade: 8 Lesson Topic

Utah SEEd Standard

Standard 8.1.7–**Design**, construct, and test a device that can affect the rate of a phase change. *Compare and identify the best characteristics of competing devices and modify them based on the **data analysis** to improve the device to better meet the criteria for success.*

Materials

- Student access to www.tinkercad.com (free)
- 3D Printer
- 3D Printer filament
- Dremel Digital 3D Slicer (to be installed on a teacher computer beforehand; we are using the 3D45-EDU model)
- Portable 23 quart freezer
- Student Notes Worksheet

Vocabulary

- Design - A plan or drawing produced to show the look and function or workings of a building, garment, or other object before it is built or made.
- Construct - Build or erect (something, typically a building, road, or machine).
- Constraints - A limitation or restriction.
- Test - A procedure intended to establish the quality, performance, or reliability of something
- Affect- Have an effect on; make a difference to.
- Data Analysis - The process of systematically applying statistical and/or logical techniques to describe and illustrate, condense and recap, and evaluate data

Directions

3D Printer: Set Up

- For help setting the printer up, follow along with this video.
- Open the following link: Dremel Digital 3D Slicer
- Click on, “DigiLab 3D Slicer for Windows”
- Open the downloaded extension
- Click “Next” until you get to “Install”
- When it says “Connect to Networked Printer” click “Cancel”
- Plug in 3D Printer
- Turn on Printer with the small switch on the right hand side

Engage

- Show students the compilation video of ice cube tray infomercials.
- Ask students to think about the problem that each company was trying to solve and discuss this as a whole group..
- Have students think about the solution that each design proposes and share their answers with a partner. Call on about four students to share an answer with the class.
- Share with students that they will engage in the engineering process too! The problem is this: A rich investor enjoys ice cold water, but hates sipping water full of ice cubes. Design an ice cube tray that melts an ice cube as quickly as possible. This will give the investor ice cold water without any ice cubes getting in the way.
- Have students fill out the constraints portion of the worksheet with what things they think may get in the way of a successful process.

Explore

- Students will be using TinkerCad.com to design a 3D ice cube tray.
- Have students explore the TinkerCad site by playing with its features for 5-10 minutes.
- Ask that each student follows along with a simple tutorial.
- Have students brainstorm and draw out at least one idea for an ice cube tray on their worksheets. Feel free to show the included example trays.
- Each student will design a single ice cube tray (to melt one ice cube) that is no larger than 40 mm wide x 40 mm deep x 25 mm tall that will hold ½ tsp of water. The shape and other design elements are up to the individual student.
- After 20-minutes, have students get together into groups of 5. Each student will pitch their idea to the group. Students should show their model in TinkerCad, explain their reasoning for their design, and give their ice cube tray a unique name.
- The student groups will vote for their favorite design among group members.
- Once a design has been chosen, the group should email it to their teacher. Instructions:
    - Click “Send To” in the upper right hand corner

- Select “Invite People”
- Copy the link
- Email the copied link to your teacher

Explain

- Each group will create a 30-second infomercial about their winning design. The goal is to convince the rest of the class to choose theirs as the overall winner.
- Have each group send their spokesperson to the front of the room to share their infomercial.
- The group’s spokesperson will have to explain the group’s logic and reasoning for why their design will melt ice the fastest
- The class will vote on their overall favorite design. (TIP: Do not allow groups to vote for their own design). The winning design will eventually be printed on the 3D printer and will compete in a melting challenge with the other class periods’ designs.
- Once a design has been chosen, the group should email it to their teacher. Instructions:
  - Click “Send To” in the upper right hand corner
  - Select “Invite People”
  - Copy the link
  - Email the copied link to your teacher
- Have students fill out the “Analyze” portion of their worksheets

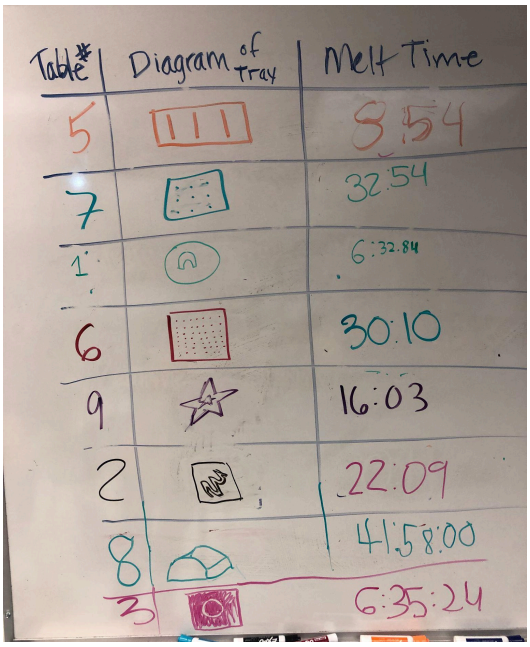
NOTE: This is a good place to end day 1 of instruction

- To 3D print the winning design, the teacher will download an .STL file for the winning group.
  - Open the winning design link in TinkerCad
  - Click “Export” in the upper right hand corner”
  - Click “.STL” under the “For 3D Print”
- The teacher will upload the .STL files into the Dremel Digilab 3D slicer that was downloaded previously.
  - Open File ➔
  - Choose the .STL files you want to print (you can put multiple files on the print tray) ➔
  - Click “Prepare” in the bottom right corner ➔
  - Insert the SanDisk Thumb Drive into your computer’s USB port ➔
  - Click “Save to Removable Drive” ➔
  - Eject the Drive ➔
  - Insert the Thumb Drive into the front of the Dremel 3D Printer ➔
  - Select “Build” from the screen ➔
  - Find your file and select “build” again

Note: Design printing time will vary. The average print time for one student design is about 2 hours. It can be helpful to begin printing a design right away, rather than wait to print all designs at the end of the school day.

Elaborate - Day 2

- After all designs have been printed, the teacher will take a picture of the set. You are welcome to include some of the sample designs that are included in the SEEdPOD!
- The teacher will freeze 1/2 teaspoon of water in each ice cube tray using the portable freezer. (The freezer takes about 45-minutes to cool down once it has been plugged in.)
- Ask students to recall what they did last period.
- Share an image with all of the printed ice cube trays. Ask students to predict which one they believe will melt the fastest. Why?
- Students should return to their groups from the previous day. One student per group needs access to a timer. One option is www.timer-tab.com on the chromebooks.
- Have one student from each group take a frozen tray from the portable freezer. Make sure that the winning group from the class period gets their own design, the other groups can choose any tray. Students should return to their table and immediately start the timer.
- Have students take data on the melting time for each tray. You can put these results on the whiteboard for everyone to see. We encourage teachers to have students report their results in a similar way to the picture on the right. While ice is melting, share some of the videos about 3D printing from this YouTube playlist!



Evaluate

- Once all the trays have melted, see which one melted fastest and have students talk with a partner about WHY the winning design allowed the ice to melt so quickly. What elements of the design sped up the process? Connect the students' responses to factors that can affect the rate of phase change (surface area, external temperature etc.).
- Share the ideas as a class. Call on around four students.
- Ask students to return to TinkerCad and make a new design that is their own version of the winning ice cube tray, this time as an entire tray of 12 ice cubes. Encourage students to make modifications to the winning design, in order to speed the process even more. Students can share their ideas as a group or with a partner as time permits.

8th Matter and Energy Inventory List

Lesson 1: *8.1.7.* - Matter and Energy

- 3D Printer
- 3D Printer filament
- Portable 23 quart freezer

Ice Cube Notes Worksheet

Grade: 8th

Designing a device to affect phase change

Define

A rich investor enjoys ice cold water but hates sipping water full of ice cubes. Design an ice cube tray that melts an ice cube as quickly as possible. This will give the investor ice cold water without any ice cubes getting in the way. **Define** the problem the investor is experiencing. Talk about it as a class or in groups.

Predict

Predict what kind of ice cubes will melt the fastest? What **constraints** might you face in the process? Write down your ideas here:

_____

_____

_____

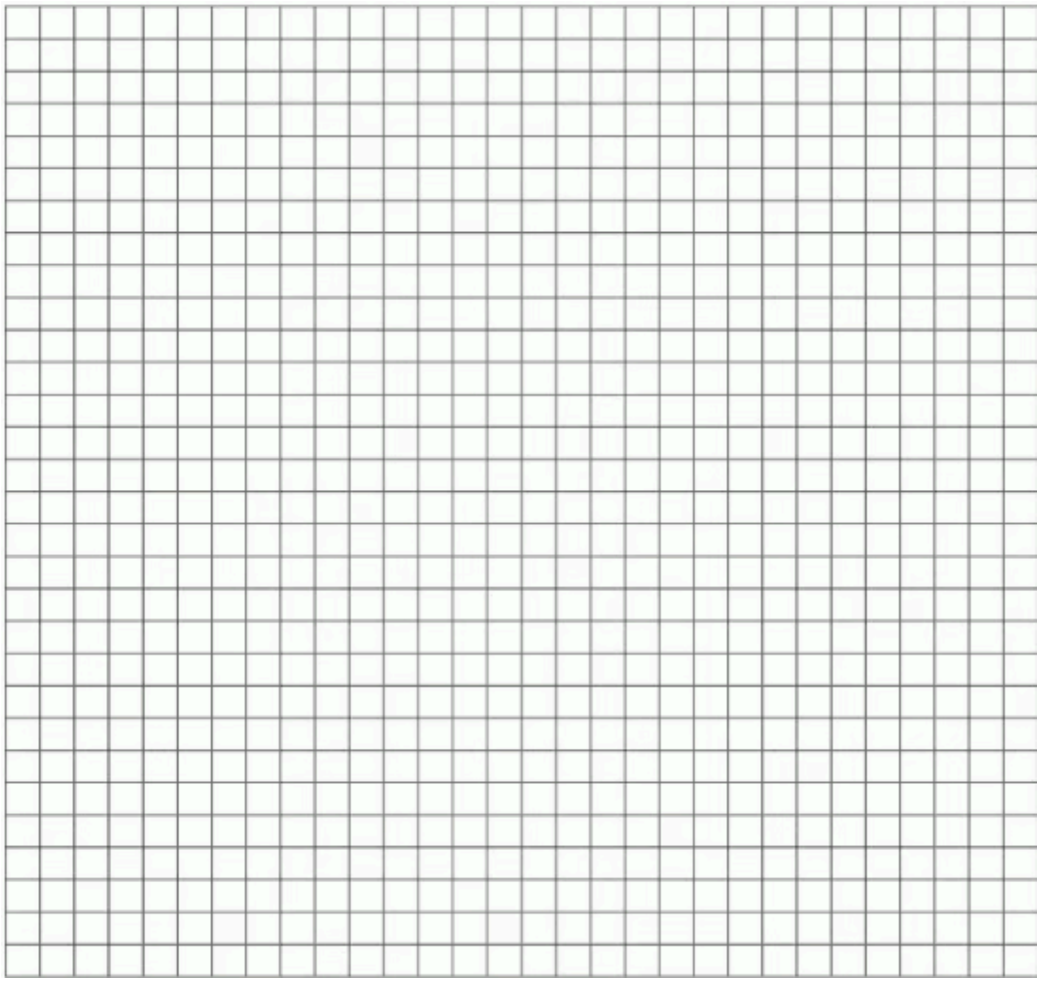
_____

Brainstorm

Draw a simple model of how you'll construct your ice cube tray.

Select: If you drew multiple models, pick the one you think will work best and circle it

Name of your design: _____



Analyze

Iterate:

What worked well?	What didn't work?

Communicate: What would you do differently next time?:

_____

_____