2nd – 8th
NGSS Aligned

CHRISTMAS / WINTER STEM CHALLENGE

Sleigh or Sled & Slope

DIGITAL/PAPERLESS VERSION

FOR USE WITH GOOGLE SLIDES

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Thanks & happy teaching!

~ Kerry

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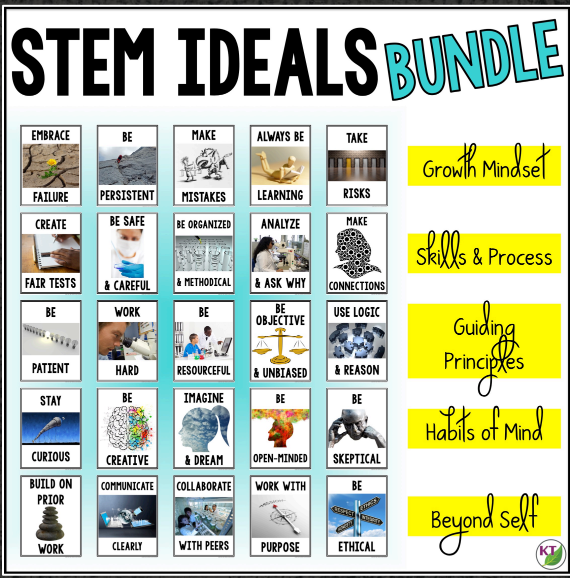
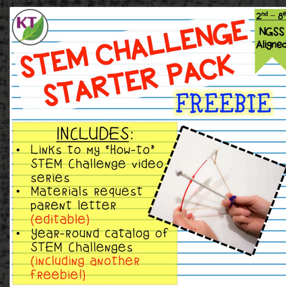
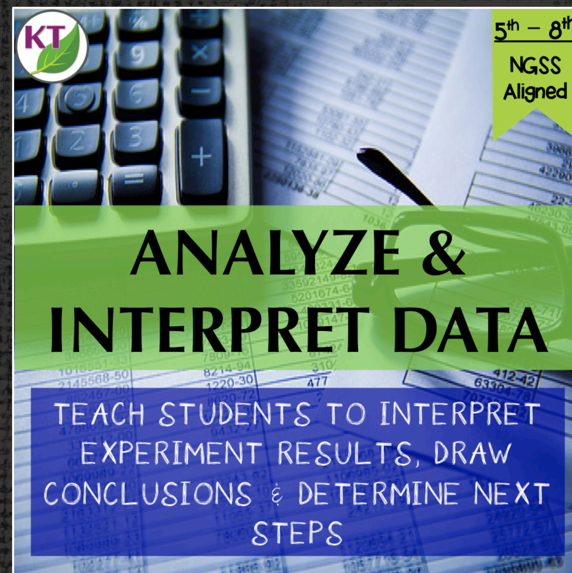
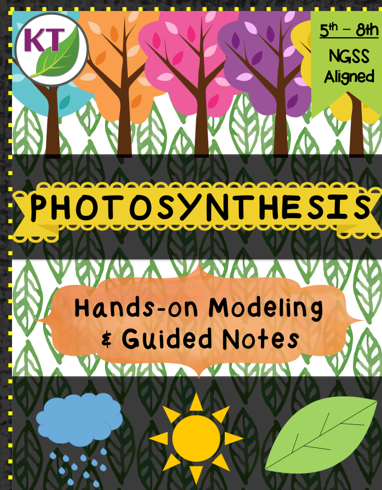
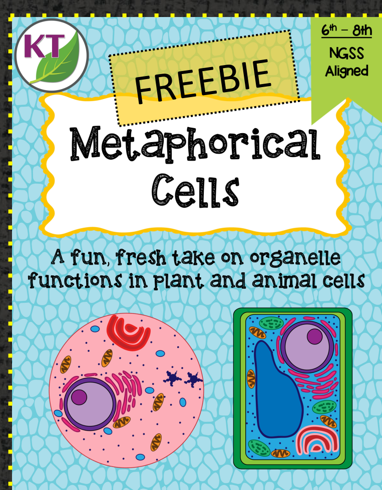
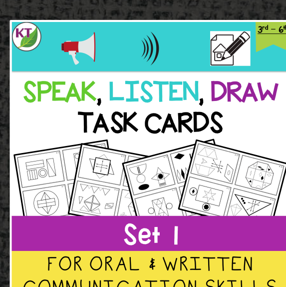






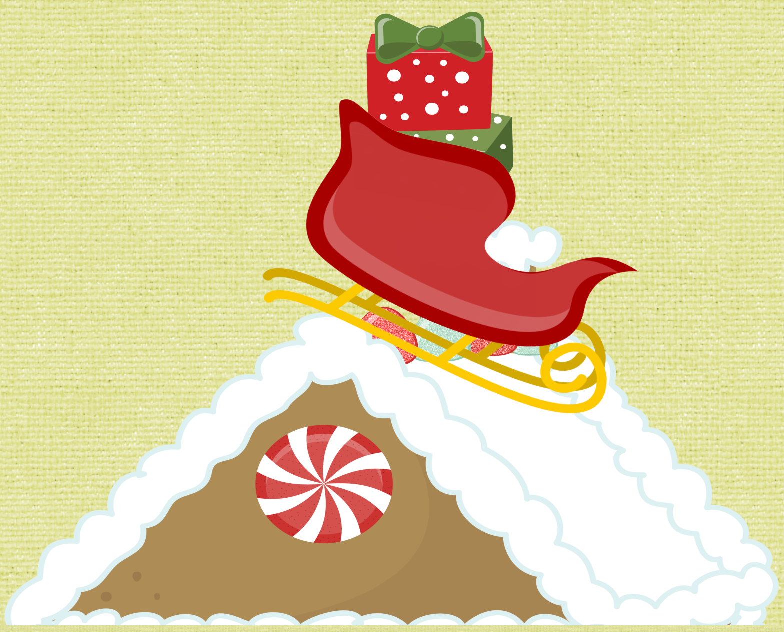






Christmas STEM Challenge:

Sleigh & Slope



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Click on any entry below to navigate through the document.

CLICK HERE TO GO STRAIGHT TO THE CHRISTMAS/SLEIGH MASTER FILE IN GOOGLE SLIDES.

CLICK HERE TO GO STRAIGHT TO THE WINTER/SLED MASTER FILE IN GOOGLE SLIDES.

GETTING STARTED

1. Your students will need their own Google accounts to access the file in Google slides. If you need help setting up Google Classroom, search for how-to videos on YouTube. I found this one helpful, but there are plenty to choose from!

2. Review the Teacher Tips for this challenge in the following pages.

3. Create a copy of the Christmas master Google Slides file and/or a copy of the winter master Google Slides file. Rename this file "Teacher" or "Master" copy. There is a video on slide 1 that provides a quick explanation of the file contents/ layout.

4. Create a second copy of the file for your students. This way, you always have a master copy with all the slides available. In the student file, delete any pages you don't wish to have students complete, or consider breaking the large file into smaller chunks (Day 1, Day 2, etc.) prior to sharing the file with your class.

Sleigh & Slope Materials

Select from the list. Most materials can be purchased at you local dollar store or Target/Wal-Mart, etc. Make sure students have an equal amount of each material provided.

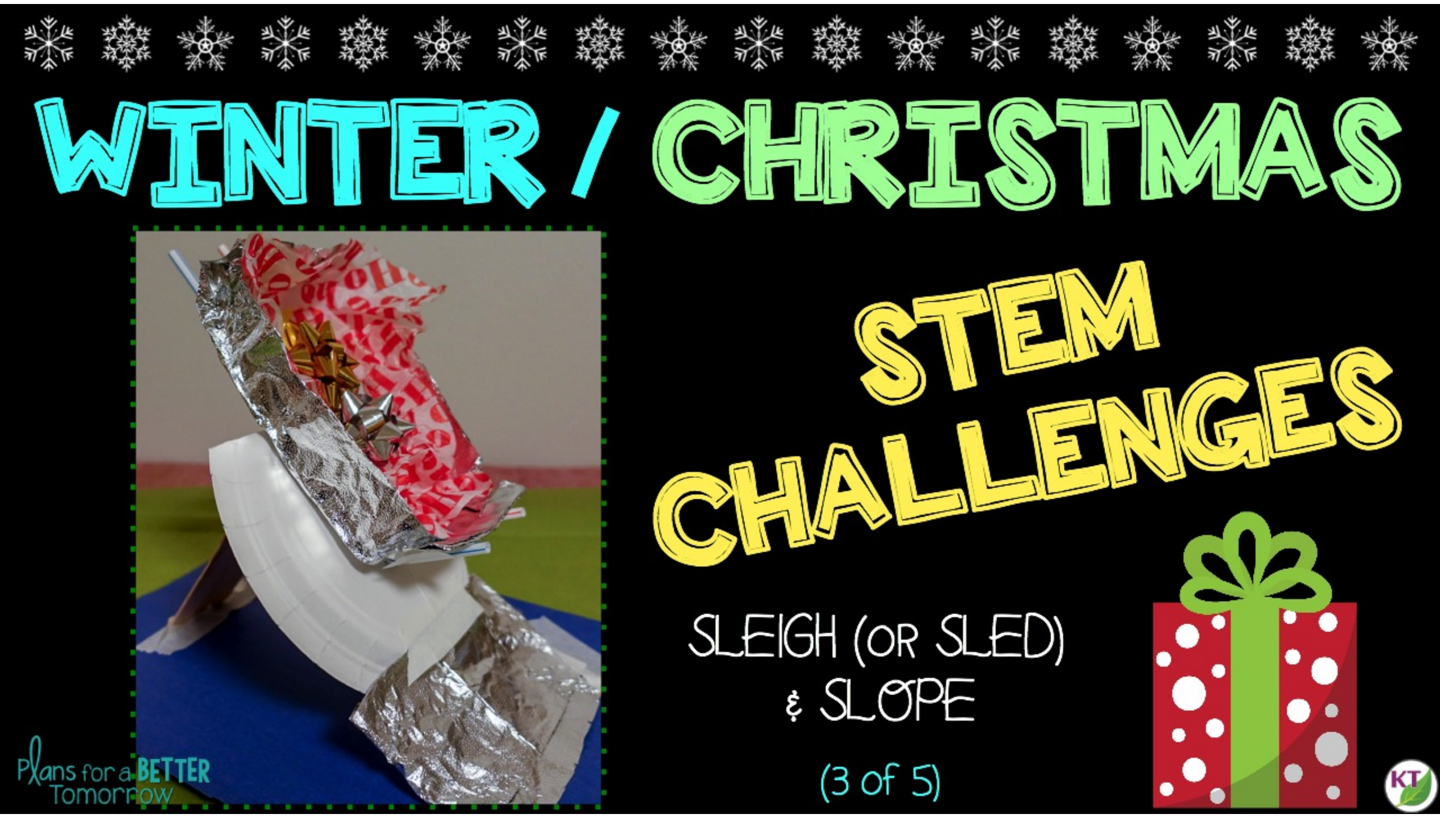
- **For each student or group:**
  - Cardboard, cardstock, cereal box, or paper plates
  - Pipe cleaners (5 – 10)
  - Small bows (2) or Small plastic people (2 -- think army-men size)
    - Bows are to symbolize gifts; small candies can be substituted
    - If you are doing the winter/non-Christmas version, Sled & Slope, you will use the same materials, except you will replace the gifts in the sleigh with riders in a sled.
  - Popsicle/craft sticks (10 – 15)
  - Rubber bands (5 – 10)
  - Foil (12 – 24 in.)
  - Straws (5 – 10)
  - Scissors
  - Tape (12 – 24 in.)
  - Ruler or measuring tape
  - Copies of data recording & analyzing handouts
  - Optional:
    - Wood scraps
    - Paper bags
    - Coffee filters
    - Plastic cutlery
    - Balloons (rocket boosters)
    - String
    - Cable ties

Cereal boxes are a great way to provide groups with cardboard.

Symbolic "gifts" can be bows or candies. For "Sled & Slope" version, use small plastic people.

Video Walk-Through

On December 8, 2016, a video walk-through will be posted for this challenge. The image below is linked to the Winter/Christmas playlist on my YouTube channel, where it will be easy to find on or after that date.



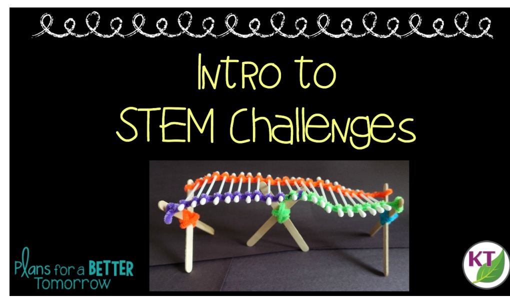
Note to Teachers

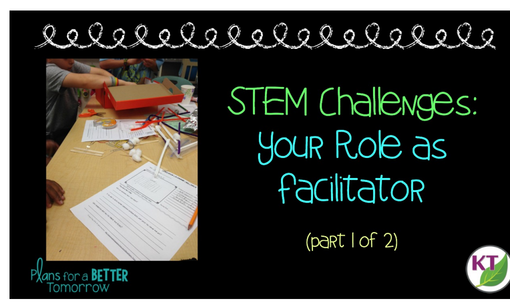
The beauty of STEM Challenges is that they are open-ended and require critical thinking and problem-solving. This is why we don't give students directions to build a specific design. In keeping with the engineering design process, a criteria & constraints list is provided to give students a framework of the design problem and goal. How they choose to address the problem and goal is entirely up to them.

You can tailor the challenge to your students' needs using the editable list provided, but don't make it too easy! Be bold and embrace the *challenge* – it's in the title after all! Understand that the potential to fail is an inherent risk, and in fact, when you're prepared for that possibility, a "failure" can turn into a far richer lesson than a success. Check out the first video linked below for more on what you can do to prepare for – and even look forward to – a potential "fail"!

Videos & PD

Video is such an effective way to share tips and examples for running fantastic STEM Challenges! I've linked a few below to help get you started and cover some troubleshooting topics as well.





You can also find my full video library & newest PD on:

If you have any questions, please feel free to reach out via email or social media!

- **Premise**
  - In partners/groups, students will build a sleigh and ramp designed to transport the sleigh the greatest possible distance.
  - Plan to give students approximately 45 min. to design, 10-15 min. to measure and share results, and 10-15 to complete data analysis slides. Additional time will be needed if you are assigning extension activities.

- **Set Up**
  - If you are new to STEM Challenges, you might find it helpful to review one or more of the videos from the previous page.
  - To save time or to simplify the challenge for younger students, build the ramp ahead of time and have all groups test on your slope.
  - Review the Criteria & Constraints List provided, and decide if you will make any modifications ahead of time.

- **Criteria/Constraints**
  - Decide on criteria/constraints list ahead of time.
    - Decide whether you will allow the following:
      - Ramps built on the edges of desks/tables (sleighs land on the ground).
        - » If not, add constraint: Ramps must be built on the ground.
      - Enclosed sleighs (spheres).
        - » If not, add constraint: sleighs must be open-air vehicles, or sleighs must never turn end-over-end/360°.
  - The Criteria & Constraints List slide provided is editable.
  - Increase or decrease the time as needed.
  - Ideas to increase the difficulty of the challenge:
    - Add criterion to contain more than two "gifts"
    - Add a criterion to make the sleigh weather-resistant
      - Windproof: gifts stay securely inside when exposed to a strong fan
      - Waterproof: contents remain dry when sleigh is spritzed or drizzled upon.
    - Add a criterion to incorporate another force (other than gravity) to propel the sleigh. The constraint remains that students can't push the sleigh, but they could use wind or a slingshot-type application.

- **Measuring Results**
  - Students should verify they have met all listed criteria/constraints.
  - Students measure and record the distance their sleighs traveled. Distance is measured from the front of the sleigh at its release to its stopping place. In order to ensure fairness, students should simple release -- not push -- their sleighs down the slope.
    - Students can either take their best trial or average of multiple trials.
    - Trial is invalid if “gifts” fall from sleigh.
    - A student slide to record multiple trials is included.
  - If age-appropriate, on the Sleigh & Slope Challenge slide, students should label the diagram with measurements of ramp height, length, and angle.

- **Post-Design Options**
  - Design analysis (slides included)
  - Discussion questions (slides included)
  - Re-design and re-test (consider incorporating new, student-suggested materials)
  - Extension activities
    - Measure the angle of the ramp. Re-set / re-build the ramp to various angles and record the impact to sleigh travel distance. Have groups share results to determine if there is consensus on an optimal ramp angle.
      - If measuring angles is age-inappropriate for your students, consider measuring ramp height instead.
      - Ask students to hypothesize other factors that impact sleigh travel distance and set up impromptu experiments to test. Some examples are listed below:
        - » Ramp length
        - » Ramp material
        - » Sleigh material
        - » Sleigh weight
        - » Sleigh balance / where the weight is placed in the sleigh
        - » Ways to reduce friction between sleigh and ramp
          - slides are provided (see: Extension Templates) to design an experiment for reducing friction.
    - Watch one or both videos about inclined planes/ramps:
      - Ramps: A Super Simple Machine ~4 min. (2nd – 4th)
      - Simple Machines – The Inclined Plane ~ 6 min. (4th – 8th)

Note: One slide per video is included in the student slides with its link.

- **Post-Design Options**
  - Extension activities (continued)
    - Watch one or more videos about friction:
      - Slipping, Sliding Science! ~4 min. (2nd – 4th)
      - Swings, Slides, and Science ~4 min. (2nd – 4th)
      - Friction: Bill Nye clip ~3 min. (2nd – 8th)
        - » The full episode in the *Bill Nye the Science Guy* series, is season 3, episode 8.
        - » If you have Netflix streaming, you can find the episode in collection 1, episode 13.
      - Kinetic and Static Friction Forces ~3 min. (4th – 8th)
      - Why Does Glitter Stick to Everything? ~2 min. (6th – 8th)
      - Intro. to Static & Kinetic Friction by Bobby ~4min. (8th – 12th)
      - Crash Course Friction ~11 min. (8th – 12th)
    - Draw a picture and label the forces acting on the sleigh as it travels down the ramp.
    - Students create a process flow map for how to make their sleigh and ramp designs. They trade process maps and try to build the other's design (process flow map slide included).
    - Students create and solve math problems related to designs (slide included).

Note: One slide per video/website is included in the student slides with its link, so you can easily assign to students.

Universal STEM Challenge Notes & How to Use the Design Analysis Slides

STEM Challenge Cycle (overview video of the STEM Challenge steps)

Planning

- Try giving students experience with different planning styles on different challenges, so they can begin to understand their own preferences. Several approaches are listed below:
  - Students begin to manipulate materials immediately
  - Students sketch ideas prior to building
  - Students discuss ideas with teammates prior to building
  - Have students jot notes for their plan prior to building
  - Students have 3 – 5 minutes of silence to think about what they will do prior to building (follow with another approach, or go straight into building)
  - Walk & talk: Introduce the challenge, then have students go on a short walk to discuss ideas with teammates prior to building
  - Free choice or mix/combine approaches

Post-Design – Design Analysis Slides

- Multiple iterations are always recommended to allow students an opportunity to apply learning, try new ideas, and to be in keeping with the engineering process. While you might not be able to do so with every challenge, try to do it whenever you can. Never conducting a second or third iteration is akin to never asking students to tell you how they *could* improve their writing, but never actually having them revise it; the execution of ideas is crucial in developing skills!
  - For each new iteration, make a new copy of the design analysis slides.
  - The following analysis question can be used in different ways: "Which was your more/most effective design? What do you think it was about the design that made it superior to the other(s)?":
    - **Option 1:** Have students consider the evolution of their design within the current iteration of the challenge. Frequently, students change aspects of the design right up until time is called. Their final version is not necessarily the best version. If they insist they stuck with one idea throughout and have nothing to compare, select option 2 or 3 below.
    - **Option 2:** Students can select what they think was the most effective design in the class, not necessarily their own.
    - **Option 3:** If you will conduct multiple iterations, students can wait to answer this question until after the final iteration, and answer it only once on the final set of handouts (or use options 1 or 2 to answer the question prior to the last handout set).

Next Generation Science Standards (NGSS)

A Note RE: NGSS Science & Engineering Practices

This STEM Challenge has the potential to hit upon all NGSS ETS standards depending on the depth and number of iterations you choose to implement in your classroom. Take a moment to review the Performance Expectations as well as the Disciplinary Core Ideas (DCIs) included here prior to inform your decisions and approach.

K-2 NGSS
Science & Engineering Practices: Performance Expectations

K-2 Science & Engineering Practices

Students who demonstrate understanding can:

- **K-2-ETS1-1.Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.**

- **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.**

- **K-2-ETS1-3.Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.**

K-2 NGSS Disciplinary Core Ideas (DCIs)

- **ETS 1.A: Defining and Delimiting Engineering Problems**
  - A situation that people want to change can be approached as a problem to be solved through engineering. (K-2-ETS1-1).
  - Asking questions, making observations, and gathering information are helpful in thinking about problems. (K-2-ETS1-1).
  - Before beginning to design a solution, it is important to clearly understand the problem. (K-2-ETS1-1)
- **ETS 1.B: Developing Possible Solutions**
  - Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (K-2-ETS1-2).
- **ETS 1.C: Optimizing the Design Solution**
  - Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (K-2-ETS1-3).

3-5 NGSS
Science & Engineering Practices: Performance Expectations

3-5 Science & Engineering Practices

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.**

3-5 NGSS Disciplinary Core Ideas (DCIs)

- **ETS 1.A: Defining and Delimiting Engineering Problems**
  - Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Difference proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (3-5 ETS1-1).
- **ETS 1.B: Developing Possible Solutions**
  - Research on a problem should be carried out before before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2).
  - At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5 ETS1-2).
  - Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (3-5-ETS1-3).
- **ETS 1.C: Optimizing the Design Solution**
  - Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3).

Teacher-Author note: I philosophically disagree with DCI 3-5-ETS1-2. With an iterative design approach, one often produces more innovative designs by *not* researching first. Design first also motivates students to have a reason to research between iterations. It's nice to have the baseline of design results before and after research as well. This challenge reflects my approach.

Middle School NGSS Science & Engineering Practices: Performance Expectations

MS Science & Engineering Practices

Students who demonstrate understanding can:

- **MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.**

- **MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.**

- **MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.**

- **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.**

Middle School NGSS Disciplinary Core Ideas (DCIs)

- **ETS 1.A: Defining and Delimiting Engineering Problems**
  - The more precisely a design task's criteria and constraints can be defined, the more likely is is that the designed solution will be successful. Specification of constraints includes consideration of specific principles and other relevant knowledge that are likely to limit possible solutions. (MS-ETS1-1).
- **ETS 1.B: Developing Possible Solutions**
  - A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4).
  - There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3).
  - Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3).
  - Models of all kinds are important for testing solutions. (MS-ETS1-4).
- **ETS 1.C: Optimizing the Design Solution**
  - Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process – that is, some of those characteristics may be incorporated in the new design (MS-ETS1-3).
  - The iterative process of testing the most promising solutions and modifying what is proposed on the basis of test results leads to greater refinement and ultimately to an optimal solution. (MS-ETS1-4).

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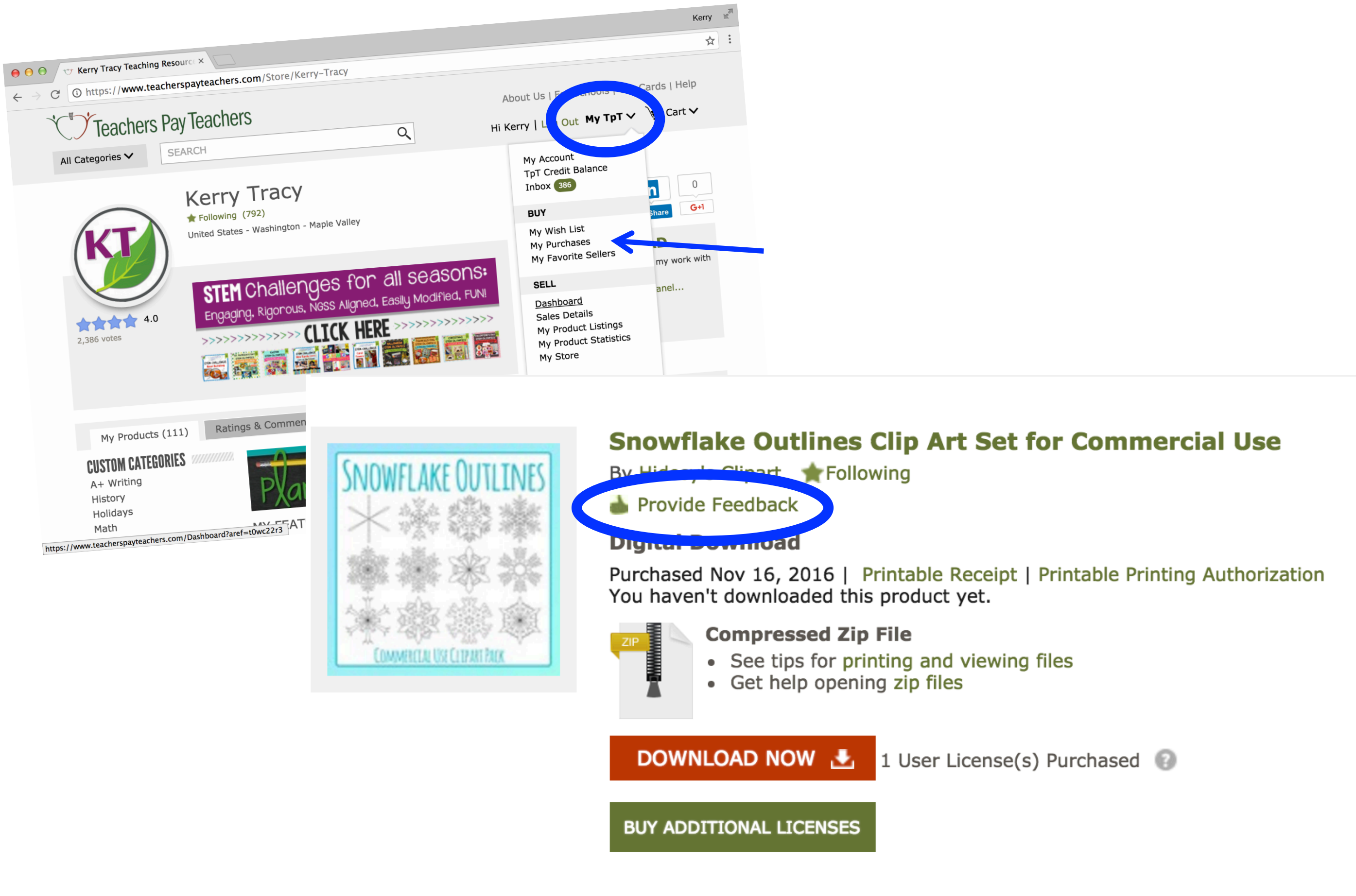

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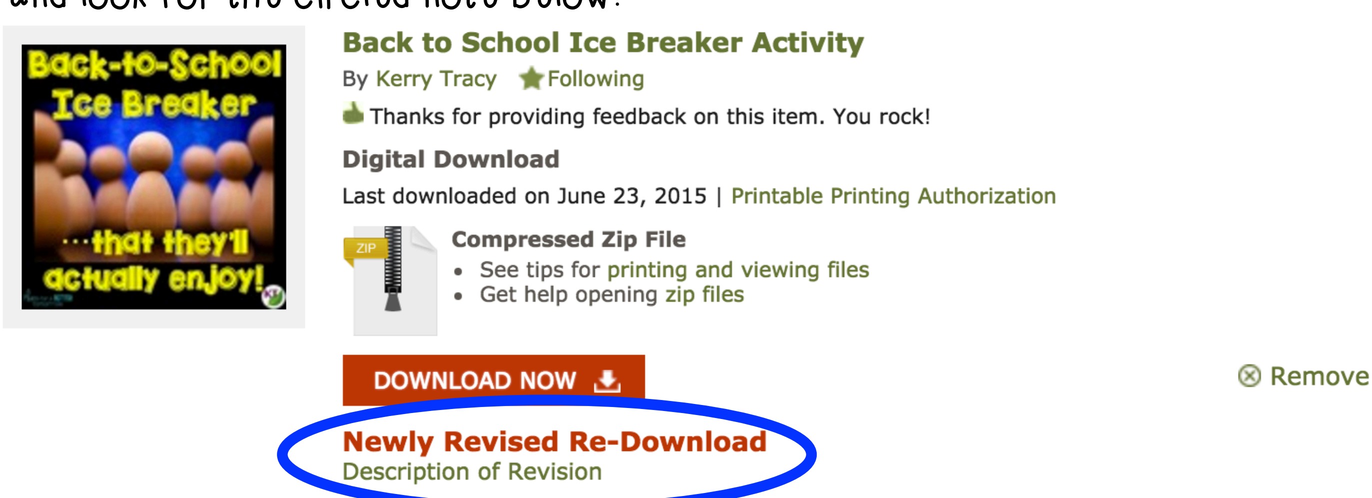

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