DiscoverE Challenge: Critical Load

Student Instructions:

Challenge
Build a house of cards and find out how much weight it can support before it collapses.

These instructions are also presented in a video by Civil Engineer Avery Bang of Bridges to Prosperity. Watch on YouTube here: https://youtu.be/NoQT0HmAR9c

Materials

- 12 playing cards
- Scotch tape
- A small cardboard platform (the bottom of a milk or juice carton works great, or you can cut down a pizza or cereal box)
- And something small to use as your weights, like pennies or paper clips

1. **Identify the Problem**
   The most critical step of any engineering challenge is to **understand the problem** you are trying to solve:
   - Using only 12 playing cards, how can you design a **flat-topped structure that supports as much weight as possible** without collapsing?
   - You will need to think like a civil engineer to figure out the **critical load**. This is the amount of weight or force that causes a structure to fail or fall apart.

2. **Brainstorm Designs and Build**
   - Spend a few minutes trying out different arrangements of cards to get ideas for which design would work best.
   - As you build, see how much tape you need to secure your structure. You can use all 12 cards, but you don't have to.

3. **Test Your Design**
   - It's time to test the strength, also known as the **structural integrity,** of your house! Will your house stay up when weight is added?
   - When you are ready, place your cardboard platform on top of your structure and count how many pennies you can add, one at time, until it collapses.
   - Be sure to add weight evenly. If your house falls down after only a few pennies, that's OK. This is why testing is so important.
   - How many pennies did it take for your structure to fail? Record the total number of pennies as your critical load.
   - Or you can calculate the critical load in grams. A US penny weighs 2.5 grams.

4. **Evaluate and redesign**
    - Think about any changes you would like to make using these questions:
        - How much weight did the house support? Could it be designed to support more?
        - Where is your structure failing? How can you strengthen the weak points?
        - Did the height of your card structure affect its ability to support the added weight?
        - What was the shape of your card structure? Is there another shape you can try?

5. **Make Changes and Try Again!**
    - Redesign your house and test again.
    - Were you able to increase the critical load?
    - Looking for another challenge? Increase the difficulty by building *without tape* or by using index cards instead of playing cards.

6. **Share Your Results with a teacher, parent/guardian, or DiscoverE!**
    - You can email photos to DiscoverE at social@DiscoverE.org or post on Instagram/Twitter using the hashtag **#DiscoverEChallenge**