Cardboard Boat Races

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A One-Week Activity Guide

Based on the Texas Tech University - Lubbock ISD Middle School STEM Challenge
www.stem.ttu.edu/challenge

1 Introduction

For a fun activity involving concepts in mathematics, physics, statistics, and hands on creativity, cardboard boat races can be beneficial to students of different ages. It gives students the opportunity to design something from the start, build their design with specific limitations in mind for a known purpose, and be able to race their boats. Depending on the age group of the students, they will be able to either use or explore concepts pulling from the STEM disciplines and applying it to building a boat. The idea of a cardboard boat race is not necessarily new or novel, and there are many different sets of rules, as doing a good amount of research would show. This is meant only to be a guideline with suggestions for doing a weeklong activity for cardboard boat races.

2 Grade Level

This activity can be appropriate for many different grade levels. Of course, it is up to the organizers to supply the necessary knowledge to the students completing the activity. For older students, the STEM concepts can be examined in a more concrete manner. For younger students, it can be used as a more exploratory activity where concepts can be talked about in an abstract way.

3 Concepts

Concepts can be pulled in from physics, mathematics, and statistics. It's up to the organizers to make the concepts match the level of the students in the program. Some of these concepts could include:

- fluid flow, pressure, and buoyancy
- relationships between displacement, velocity, and acceleration (physics)
- finding velocity and acceleration when position is known (using calculus)
- using multiple measurements of the same data points to obtain an average for data points
- using data points and linear regression to determine the equation of a line.

4 Materials

The materials used for the entire week include materials for mini challenges in the mornings. The materials for each individual challenge are listed in the attached PDFs. Since those projects are easily able to be switched out with other activities, we left those materials out of this file and only list the materials needed to perform the cardboard boat race of the aspect, along with the materials for the first day's activity.

Cardboard Boat Race:

- Cardboard
- Duct tape
- Box cutters
- Stop watch
- Towels
- Transportation
- Life jackets
- Paddles
- Pool or lake
- Life guards

First Day's Activity:

- Tin or aluminum Foil
- Marbles or Pennys
- Large sink/ storage tote/ kiddie pool

5 Preparation

This module is heavily based upon the students building and getting hands on experience themselves, so student preparation time should be limited. The most important preparation is for the students to have the previous knowledge desired and for a sufficient amount of time and supplies. For the organizers of the week activity, planning the location of the event must be taken care of (both the workspace and the actual races themselves, since this is often not in the same area). Although there is a schedule provided in this document, planning and time allotment should be part of preparations. If possible, the materials purchased ahead of time for the mini projects should be sorted out and organized into days, and into the number of groups if possible. For the students, there should be minimal preparation. If the students have all the prior knowledge requested, a waiver should suffice. If more knowledge is desired, a small reading assignment or homework assignment could be given ahead of time. Along with the liability waivers, permission to use photographs and video of students should also be acquired, as these events can draw media attention, and we do recommend taking pictures of the building process as well as the races.

6 Safety Precautions

As always, there are safety concerns. During the construction of the boat, care must be had when using sharp objects like box cutters or knives. It is important to use normal laboratory safety rules if the work space is in a laboratory. When doing this activity with younger children, we imposed the rule that only adults can use box cutters. In addition to this, the actual race will be in water. Either a pool or an outdoor body of water may be used, depending on the organizers' preference and what is available. With this, each student who is in the water should wear a life jacket and there should be a sufficient amount of life guards on duty. While rules and practices will vary depending on the host, liability release forms may need to be signed by participants and their legal guardians. Keep in mind that separate forms may be necessary to account for the building activities and the actual racing.

7 Schedule

For a one-week activity, the following schedule is proposed. It assumes a 9:00 a.m. - 4:00 p.m. day with a one hour lunch break from 12:00 p.m. to 1:00 p.m. Some of the activities may not take as long, depending on the age group. It is recommended that students be encouraged to take their time. For the mini challenges, it's also encouraged that students watch the results of the other teams. The links to the mini challenges in the morning will be found below.

	Morning	Afternoon
Monday	*Aluminum boats*	Cardboard boat design and test
Tuesday	*Super Subs*	Cardboard boat build
Wednesday	*Battle of the Boats*	Cardboard boat build
Thursday	*Super Structures*	Cardboard boat build
Friday	Boat Race	Award Ceremony

Monday: `http://jmsalsich.edublogs.org/2012/02/26/building-boats-2/`

Tuesday: `http://school.discoveryeducation.com/networks/junkyardwars/pdf/junkboxssubs.pdf`

Wednesday: `http://school.discoveryeducation.com/networks/junkyardwars/pdf/junkboxboats.pdf`

Thursday: `http://school.discoveryeducation.com/networks/junkyardwars/pdf/junkboxwars.pdf`

8 Storage and Disposal

Be careful to ensure that no cardboard or duct tape will be left behind in the pool or body of water. (If using a pool, it's best to coordinate ahead of time who will be in charge of disposal; sometimes the staff at the pool will prefer to handle cleanup themselves though this should not be assumed.) There should be a dumpster or waste container nearby to put the cardboard in afterward. While cardboard boats should not involve any hazardous materials, the example project required an extended cleanup time as the boats were quite heavy (soggy) and partially collapsed by the end of the races. For storage, room in the back of a large classroom would be sufficient for the boats until the day of the race.

9 Suggestions

Although decoration and design are fun, and encouraged, it is recommended that paint not be used on the boats. Many paints are water based and are therefore not a good idea for natural bodies of water or welcome at pools of any sort.

It is recommended to give rules in terms of amount of duct tape they are allowed to use. For example, seams can only be 3 inches wide, and you may only have up to 2 layers of duct tape in any one spot. This would prevent groups from waterproofing their boats with duct tape. Whatever the rules are, we suggest giving a clear and precise layout of the rules at the beginning of the competition before any of the building begins, and of course, encourage questions. Long lists of strict rules may be avoided by limiting the amount of materials each team has. (Limiting the students to using only what is provided forces them to use their resources wisely or risk failure in the races.)

It is also recommended that not all of the supplies be immediately distributed. Since it is a competition, supplies can be used as awards for the winners of the morning challenges, and it may be wise to withhold some supplies until the middle of the week. Group size and the desired degree of difficulty should inform the amount of cardboard and duct tape provided to each group. In the example project, each team had four students and were provided five new large moving boxes and multiple used boxes at the beginning of the week. Three rolls of duct tape were also provided, of varying quality. **It is highly recommended not to use the cheapest duct tape available.** Midway through the week, the students were allowed to get the remaining boxes and a special guest (*Raider Red*) dropped by with an extra roll of high quality duct tape when the students are at lunch. However the delivery system, it allows a sense of scarcity in the supplies and also allows the organizers to give the supplies that the teams need after observation. Each team may need an adult working with the students, and if possible another adult to help. In the example implementation, a middle school teacher and a college student were paired with each team.

Suggestions about how to actually build boats, along with pictures, can be found in the accompanying slide show.