Turkey Bowl

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Purpose

This activity introduces students to the use of computer simulations to solve physics problems, specifically to solve for the masses of colliding objects and identifying the types of collisions that occur. Students are required to develop their own strategies to solve the problems with the tools provided. This lesson is designed to smoothly lead to further, more in-depth, lessons in the future. We hope to foster interest in further programming and encourage especially interested students to attend the data science club.

Overview

-A day before the main activity, give the students the pre-lab, which should be completed either in class or for homework. The worksheet reviews the physics of elastic and inelastic collisions and introduces the main questions for the lab (finding the masses of the objects in the simulation), as well as a few extra credit questions.

-The teacher should either install processing (including Python mode) or create an easily downloadable file with the program and processing.

-At the beginning of the main activity, the teacher should review the pre-lab with the class, preferably after having all the students set up processing, reviewing collisions and explaining what the program does.

-The first step for the students is to log into the computers and open processing. The students should then open the program, ‘Turkey Bowl’ within processing and begin exploring the program.

-The students should then, in pairs or in groups, discuss the strategies for collecting data and answering the main questions of solving for the object masses and identifying the types of collisions that occur. The data should then be collected and recorded in their lab books.

-The students should solve for the masses, and any students that finish early should begin working on the extra credit questions which require using the friction and air resistance options in the program.

Student Outcomes

1) Introduction to processing
2) Review of collisions, seen in simulations
3) Experience with experimental design and data collection
4) Using a simulation to explore a physical problems

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Applications of learning – The students apply their knowledge of elastic and inelastic collisions to develop an experiment and collect data.
Communicating – The students must defend their reasoning behind their experimental design.
Using technology – The students learn to use a program written in processing that simulates the physics behind solving a problem, similar to the methods used in modern research.
Working on teams – The students will work in groups to develop a strategy for solving the questions presented in the pre-lab as well as collecting data.
Making connections – We hope to introduce to students the power behind using computer simulations to model physical systems.

Standards Addressed

HS-PS2-2 – Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.
HS-ETS1-4 – Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Time

The total time for the activity is one class period for going over the pre-lab and two class periods, preferably together, for the main activity. The activity runs much more smoothly if the students have been introduced to basic programming previously.

Level

This activity works best for students that have had algebra and have gone over both energy and momentum in physics class.

Materials and Tools

A computer lab or personal laptops with processing already installed or in an easily downloadable folder with all the files required. The pre-lab worksheet given the class period before the lab allows the students to begin formulating ideas on how they will design the experiment and collect data.

More information on Processing can be found here. (https://processing.org/)
Pre-lab worksheet can be found here.
Required Processing files can be found here.

Preparation

The teacher needs to download and use the program to become comfortable enough to answer both physics and technical questions. The teacher should also document how to download and run the program on the school's computers, as this may require a different setup.

Prerequisites

While there are no strict dependencies on prior activities, having done an activity that introduced computer simulations would make the activity run more smoothly. Having the students review the physics (elastic and inelastic collisions) will help when designing the experiments.

Background

Students should be familiar with the physics dealing with energy and momentum during elastic and inelastic collisions. Algebra is needed to perform the analytic calculation.

Teaching Notes

The students will work at different paces, largely dependent on their prior experience with computer programs. Be sure to check if students are stuck with technical issues, as this can cause much time to be lost and can cause frustration. Some students, perhaps familiar with computer programming, may finish the activity quickly and should be directed to the extra credit questions that introduce air resistance and friction. Students are highly encouraged to document their reasoning behind their experimental design and to record all the data taken. Encourage the students to work together, especially due to the potentially large range of computer skills.

Assessment

-The students should have completed the pre-lab with an introduction to the tools, as well introducing the main problems to be solved during the lab.
-Students will use the tools given to solve the problem, developing their own strategy, which must be written out in their lab books.
-While obtaining the correct answer is the most objective way to measure success, more emphasis is placed on thinking through the problem, and students must give evidence for the data collected and how the data translates to the answer.
-Students will be primarily assessed on the strategy used to solve the problem. Advanced students are given bonus scenarios to solve as well as the opportunity to look over the code.

Additional Information

-Prior to this activity we had introduced computer simulations in Excel. This step helps the understanding of computer simulations in physics.