CMST Challenge 2005
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Abstract:

This lab was written for a regents level earth science class to aid in the investigation of Kepler's Laws during the astronomy unit. Many students find it difficult to comprehend and visualize the motions in our solar system. This lab was designed to increase understanding about Kepler's Laws and the revolution of the planet's around the sun.

The planets in our solar system have an elliptical orbit around the sun. The shape of the planet's orbit causes the distance between the planet and the sun to vary throughout the revolution. The varying distance causes relatively minute changes in the planet's orbit. This study/project is to investigate why the velocity of the planets vary in their revolution around the sun. The distance changes but what is affecting the velocity?

In order to investigate the question a model was created to simulate a planet's revolution around the sun. The model is not to scale and greatly exaggerated in order to encourage students to experiment with finding the balance between forces of the sun and the planet in order to get it to revolve and not drift off into outer space or crash into one another. Once the model was complete observations were made and a hypothesis was formulated.

From the model data was collected to analyze. The data collected included the velocity of the planet, and the gravity of the planet. Both variables were recorded against a time of 30 seconds with one complete revolution averaging to be about 6-8 seconds. Two graphs were plotted to view the relationship between the gravity and velocity one with a time of 30 seconds and one with a time of 8 seconds.

From the data it was concluded that the varying distance between the sun and the planet causes the planet and sun's gravitational forces to vary. The greater gravitational force occurred when the planet was closest to the sun and the least when the planet was furthest from the sun. There was a direct relationship between the gravitational force and the velocity. As the gravitational force increase the velocity increased.

Justification of Modeling Software:

For this investigation Interactive Physics (IP) was chosen for the modeling software because it is capable of simulating gravity and how it may affect objects in different situations. The model is a great visual tool for the students to understand how changing variables can affect the balance of our solar system. IP was also used for its ease in exporting data to Excel.

Excel was used to analyze the data imported from IP. Excel was used to create colorful graphs of the data collected so that it may be analyzed.

Problem Definition:

The planets in our solar system have an elliptical orbit around the sun. The shape of the planet's orbit causes the distance between the planet and the sun to vary throughout the revolution. The varying distance causes relatively minute changes in the planet's orbit. This study/project is to investigate why the velocity of the planets vary in their revolution around the sun. The distance changes but what is affecting the velocity?

Problems Encountered:

Throughout this investigation there were a few challenges. The graphing proved to be the most challenging. Graphs at first came out upside down, among other shapes.

After seeking help from Paul Conrow, a physics teacher here at East High School we found that the wrong variables for velocity and gravity were being graphed. He gave me the physics and mathematical explanation for the phenomena and we tried to graph them again. It was truly a learning experience. Shortly afterwards we were able to create accurate graphs.

Evaluation of Results:

Chazz was extremely engaged throughout the lab investigation and came in everyday asking where my laptop was. There was definitely motivation on his part. He completed the lab during his lunch periods. I also found that many students were interested in what he was doing. When things got complicated with the graphing he didn't give up because he wanted to see the results.

The lab results were right on with predictions that Chazz made. He was able to observe the phenomena of the changing variables and then graph them. I noticed that he was eager to interpret the graph in order to see if he was correct in his hypothesis. Whereas, sometimes students just go through the motions of a lab just to say they did it. This lab was much more engaging.

Summary of Experience:

Overall I was satisfied with the results. I think this lab is great to do at the beginning of the year with my earth science students and then they will have the experience to complete more complicated labs using the programs later on in the year. I felt that this lab was more engaging and helped students to enhance their computer skills.

I am excited because my goal is to transition my labs into more technology based labs to better prepare my students for college and beyond. I am happy to say that the CMST program has been instrumental in taking that first step towards accomplishing my goal.

Standards Addressed:

NYS Earth Science Curriculum Standard 4

Key Idea 1: The Earth and celestial phenomena can be described by principles of relative motion and perspective.

Performance Indicator 1.1

Explain complex phenomena, such as tides, variations in length of day, solar radiation, apparent motion of the planets, and annual traverse of the planets.

Major Understanding 1.1a:

Most objects in our solar system are in regular and predictable motion.

- ✶ Gravity influences the motions of celestial objects. The force of gravity between two objects in the universe depends on their masses and the distance between them.

Major Understanding 1.1b:

Nine Planets move around the sun in nearly a circular orbits.

- ✶ The orbit of each planet is an ellipse with the sun at one foci.