**Lesson Plan**

**COSMOS EDUCATIONAL TOOLKIT: LESSON NAME: Simulated Egg Drop activity**

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| **Grade/ Grade Band**: *12* | **Topic:** *Instantaneous Velocity* | **Lesson #** *1* **in a series of** *4* **phases** |
| **Brief Lesson Description**: It’s basically an egg drop contest but a technology twist. *The egg drop experiment/contest was for students to construct an apparatus to protect their egg. The main goal was for an egg contest is for the egg not to break. This particular lesson builds on this philosophy and adds the component of calculus whereby students will have to find all relevant information prior to construction and testing of their apparatus. Students will determine the change in velocity over the path that their apparatus will travel. In addition they will calculate the distance traveled by finding the area under the curve using Rieman sum. This lesson will provide a hands on application that utilizes the difference quotient rule to find the velocity at different times and Rieman sum to find the area under the curve which is the distance traveled.*  |
| **Specific Learning Outcomes:** *The essential element that students will know after the lesson will be the ability to associate a real world example with math concepts learned at the beginning of a Calculus.* |
| **Narrative / Background Information**  |
| **Prior Student Knowledge Required:** *Having a strong background in algebra which would aid the students. Spatial understanding that would aid when the students make a sketch of the scenario. Students should also have experience solving real world problems.*  |
| **Problem Solving Practices (Ex: Standards for Mathematical Practice):** PS2.A: Forces and Motion Newton’s second law accurately predicts changes in the motion of macroscopic objects. (HS-PS2-1) Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. (HS-PS2-2) If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. (HS-PS2-2),(HS-PS2-3) This is a physics standard and not a math standard. But applies to this lesson. | **Main Content Ideas:** *Students will learn through inquiry and discovery that the math concepts they are learning have real applications.* | **Possible Multidisciplinary Concepts:** *The usage of velocity relative to location has many applications. It opens the ability to calculate a multitude of options. Some may include: vehicle traveling, ship travel, animal/human movement.* |
| **Possible Preconceptions/Misconceptions:** *The students will have the opportunity to apply the math that they learned with a hands on activity usually found in a Physics class.*  |
| **LESSON PLAN – 5-E Model**  |
| **ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions:** **Day 1: First Task**Students will receive a google spreadsheet prior to the first day where the students will share their height. Students should measure height to the nearest tenth. You could put a few tape measures attached to a wall for students to measure exact height. **Phase 1:**Students will research a model of an apparatus that in theory will house an egg. For this experiment, students will use a plastic ball with a sensor in it to gather information in real time instead of an egg. A simple apparatus will be designed that will cushion the balls fall. Students can design their apparatus using popsicle sticks, rubber bands, toothpicks, paper clips, straws, styrofoam cups, bubble wrap ... This is attended for a math class and not a Physics class. The emphasis of this experiment is for students to determine the math behind the objects path. Students will be given a set of goals that they must achieve. Students will calculate their predictions including velocity, average velocity, distance traveled and acceleration. Students should have prior knowledge of using the difference quotient (1st derivative) and Reiman sum (curve using left, right, middle) to find the distance traveled.Students will:* Use their own height plus which floor they are on comparative to the ground.
* Each class will drop from different floors or the same floor.
* Find the quadratic equation to describe the path of the projectile motion.
* Using Newton’s law of motion. s=position, so=Initial Height, vo=initial velocity, a= acceleration due to gravity, t=time. ***Neglecting air resistance***.

 ,* Students will design and make all calculations for teacher approval before proceeding to Phase 2.
* Students will predict how long it takes for the ball to hit the floor.

**Phase 2:** Students will construct the apparatus that they chose to design. The students need to know the size of the ball that will be placed into the apparatus by the teacher. * The ball is free standing and not taped down.
* The ball should NOT fall out of the apparatus.
* The impact should cushion the ball’s fall.
* Students will be encouraged to test it at home with a ball that is similar in size. ie: Tennis ball.

**Phase 3:**Students will bring in their apparatus and test them during class with the COSMOS sensor. Students will see if there instantaneous rate of change for which they predicted is close to the actual real world application. Students can find a new equation based upon the experiment and then compare it to there predicted equation.* Students will find the gravitational force, impact and speed of the apparatus. Using the micro:bit it will give its position relative to x, y and z. It also gives the acceleration value of milli-g, which is 1/1000 of a g-force. A g-force is the magnitude of acceleration that you get from Earth’s gravity.

<https://www.convertunits.com/from/millig-unit/to/g-unit>* Students must take into account the height of where it is being dropped.

 **Phase 4:**Students will make conclusions and compare their predicted model with their actual test. <https://m.wikihow.com/Calculate-Instantaneous-Velocity>* [Interactive online](https://www.physicsclassroom.com/Physics-Interactives/Momentum-and-Collisions/Egg-Drop/Egg-Drop-Interactive)
* Students will have to find the area under the curve using left, right, middle Riemann sum
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| **EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions:** * *Possible Transmission devices: Computer program and COSMOS equipment.*
* *Other equipment may be used.*
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| **EXPLAIN: Concepts Explained and Vocabulary Defined:** **Key Vocabulary:**  |
| **ELABORATE: Applications and Extensions:** *An extension would venture into some of the other examples that were shared above in the multidisciplinary concept section.* |
| **EVALUATE:** **Formative Monitoring (Questioning / Discussion):** **Summative Assessment (Quiz / Project / Report):**  |
| **Elaborate Further / Reflect: Enrichment:**  |