Topic: Newton's 2nd Law - Law of Acceleration

Teacher:
Genre: Physic **Unit: Force & Motion**
Grade Level: 8th Grade **Duration: 3 days**

Essential Question
(Domain 1: Planning and Preparation-Component 1c: Designing Coherent Instruction)

- How does force affect a moving object?

Background Knowledge

Background Summary:

Students are expected to have an understanding of how Newton's 2nd Law describes the motion of an object. They will be introduced to the EV3 robot acceleration program to investigate the effect of mass on force. Newton's Second Law states that the acceleration of an object is directly related to the force applied to the object and oppositely related to the mass of that object. Students should be able to make connections between mass, acceleration, and force**.**

Lesson Objectives:

- Students will be able to investigate how mass affects force by using the scientific method
- Students will be able to use the EV3 robot to model the relationship between mass, acceleration, and force
- Students will be able to collect and analyze data by answering follow-up questions and graphing data
- Students will be able to create a scientific explanation by creating a C.E.S.R. conclusion

Standards
(Domain 1: Planning and Preparation- Component 1a:Demonstrating Knowledge of Content and Pedagogy)

- **MS-PS2-2** Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
- **PS2.A: Force and Motion** The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. the greater the mass of the object, the greater the force needed to achieve the same change in motion. for any given object, a large force causes a larger change in motion.

Vocabulary (Domain I: Planning and Preparation - Component 1e: Demonstrating Knowledge of Students.)	**Prep Work/Materials (Domain 1 Planning and Instruction-Component 1e: Designing Coherent Instruction, Domain 3 Instruction-Component 3c: Instruction Engaging Students in Learning)**	**Cross Curricular Connection (Domain I: Planning and Preparation - Component 1a: Demonstrating Knowledge of Content and Pedagogy, Component 1b: Demonstrating Knowledge of Students.)**

force acceleration mass Newton's Second Law	Ev3 Robot Triple Beam Balance pencils data table handout lab sheet to report hypothesis and conclusion Lesson Powerpoint CESR rubric lab report rubric	**Stability and Change** Explanation of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales.

Differentiation
(Domain I Planning and Preparation-Component 1e: Designing Coherent Instruction, Domain 3: Instruction - Component 3b: Using Question and Discussion techniques Domain 3: Instruction - Component 3c: Engaging Students in Learning)

Two-fold instruction: PowerPoint

Do- Now Re-cap (pre-assessment from lesson prior)

Graphic Organizer

Target grouping – Student teachers grouped based on reading levels, literacy levels, and behavior concerns

Observation/Inference model based on images and text

Stop and Jot (Turn and Talk) to engage in higher levels of Blooms Taxonomy (Thinking and questioning)

Teacher circulation, cold call

Procedure **(Domain I Planning and Preparation-Component 1e: Designing Coherent Instruction, Domain 3: Instruction - Component 3b: Using Question and Discussion techniques Domain 3: Instruction - Component 3c: Engaging Students in Learning)**	**Student Engagement** **(Teacher Assessment)**
Day 1 - Present the real world scenario problem **TP: I can create a hypothesis about how mass affects force.** 1.Do Now: Which guy would make the vehicle accelerate faster? Explain why? 2. Present the scenario: ShopNow Robot problem. 3.Present the testable question: How does mass affect the force? 4. make prediction: Which family's groceries will create the lowest for the moving cart? 5. Create a hypothesis to describe which family's grocery list will produce the lowest force. If... then.. because ... 6. Share and discussion: 1) What is your group investigating? 2) why is this investigation important? 3) which family's grocery list do you think will produce the lowest force? **Day 2- Collect data with the robot** **TP: I can investigate how mass affects force.** Do Now: On your lab sheet, put a star next to your written hypothesis. Answer the following:	1.Students make prediction about the problem. 2. Students use the robot to model the problem and collect data. 3.Exit ticket of the discussion problems. 4. CESR graphic organizer for the conclusion. 5. Lab report to present the data.

a) What is your group's IV?
b) What is your group's DV?
c) Is your hypothesis weak or strong? In 1 sentence explain why.

1. Review the lab roles and select a role for the day: (*Write role here*) _____
2. Gather all materials.
3. Use the triple beam balance to measure the mass of Family A's groceries and record that value in the data table.
4. Repeat step 3 for Family B and Family C.
5. Get the Ev3 robot.
6. Place Family's A groceries on the robot's cart.
7. Using the brick, input the mass for Family A's groceries.
8. Place the robot on the starting line and run the program.
9. Look at the display screen on the robot and record the calculated force.
10. Repeat steps 6-9, for trial 2 and trial 3.
11. Repeat steps 6-10 for family B and Family C.
12. Based on your data, calculate the answer force for each Family's grocery cart.
13. Complete the Follow up Questions.

after collecting the data, students will share and discuss the result.
1).What do you think will happen if the cashier is hit with lowest mass, or highest mass carts?
2)Describe the relationship between the mass and the force when the acceleration was kept constant.
3)What will be the relationship between the force and the acceleration when the mass is held constant?
4) Which law of motion do you think your experiment relates to?

Day 3 - Data analysis and conclusion
TP: I can create and analyze a bar graph that illustrates the results from my finch beak lab.
Do Now: (analyze the graph on the powerpoint slide)
1) Do graphs use qualitative or quantitative observations?
2) What is the purpose of making a graph?
1. Students will graph the data and analyze the trend of the data.
2. Students will write a conclusion using the data with the CESR graphic organizer.

Assessment *(Formative or Summative)* (Domain 1 Planning and Instruction- Component 1e: Designing Coherent Instruction, Domain 3 Instruction- Component 3c: Engaging Students in Learning, Domain 3 Instruction- Component 3d: Using Assessment in Instruction)	**Student Engagement (Teacher Assessment)**

1.exit ticket for the discussion questions. 2. CESR graphic organizer for the conclusion 3. lab report 4. graph data and data analysis 5. Rubric for CESR 6. Rubric for the lab report Homework / Extension complete the CESR lab report for Newton's 2nd Law of motion	
Additional Resources	
Newton's second law NFL video https://youtu.be/qu_P4lbmV_I Newton's second law in the space https://youtu.be/WzvhuQ5RWJE	