5E Lesson Plan
(Earthquakes)

Teacher: Erika Lozada and Jessica Beltran (Guided by Dr. Hanna Kim)

Topic: Earthquakes (Earthquake simulator)
grade level: 6th grade

Materials:
Lego Mindstorms EV3 kit

Extension Materials:
Extra Legos

Next Generation Science Standards (NGSS)
MS-ESS3-2. Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

CCSS
CCSS.ELA-LITERACY.SL.6.1.B
Follow rules for collegial discussions, set specific goals and deadlines, and define individual roles as needed.
CCSS.ELA-LITERACY.SL.6.1.C
Pose and respond to specific questions with elaboration and detail by making comments that contribute to the topic, text, or issue under discussion.

Science and Engineering Practices (SEP)
SEP 1- Asking Questions and Defining problems
SEP 2- Developing and Using Models
SEP 3- Planning and Carrying out Investigations

Crosscutting Concepts (CCC)
CCC2- Cause and effect: Mechanism and Exploration
CCC4- Systems and System Modes

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Integration with Math Practices (MP)
MP4- Model with Mathematics
MP5- Use appropriate tools
MP7- Look for and make use of Structure

Lesson objective(s):
Students will be able to:

- Identify
- Compare
- Create
- Evaluate
- Apply

Misconceptions about Earthquakes

- Earthquakes happen randomly across the earth's surface.
- The ground opens up during an earthquake.

Differentiation strategies to meet diverse learner needs:

EL Students:
Students will be provided with synonyms for the vocabulary words.
A worksheet with the LEGO pieces and their names will be printed in English and Spanish.

Gifted Students:
Gifted students will work by themselves.

Students with LD:
Pictures of each step by step will be printed out for students to follow along.

ENGAGEMENT

- Will begin class by creating a KWL chart: K (What students already know), W (what students want to learn), and L (what students learned) this chart will engage students to learn about earthquakes
- Then students will watch this animation of an earthquake that took place in Mexico, Puebla. https://www.youtube.com/watch?v=0ag99jKAt-o
- Students will share what they thought of the film.
- Earthquakes in the world (US, Japan, Mexico, Peru, Hawai etc)
- Cause of earthquakes (san andreas fault, P wave and S wave, etc)
- Vocabulary list (epicenter, tectonic, plate, earth crust, fault line, P and S wave, magnitude/scale etc)
- Teacher asks the students what they can do to prevent from being hurt or their belongings from being destroyed in an earthquake. Teacher asks the students to pair up with their elbow partner to share their response.

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EXPLORATION:

Build and program an earthquake simulator and model buildings

Following building instructions, students will form groups to create and program a robotic earthquake simulator using the Lego Mindstorms EV3 kit. After this, they will construct and test their own building designs with the simulator to determine the structural integrity in the event of an earthquake.

1. Simulator Construction
This model utilizes an elevated programmable brick, a cart to represent the test region, or "ground," and a piston to create the pushing/pulling motion for the cart, thus creating a basic simulation of an earthquake.
2. Introduction to Coding: Hour of Code
In coding the model, it's important for the students to understand the basic principles of programming. To that end, an hour will be spent on the Hour of Code website, where the students will learn these concepts via introductory coding.
3. Introduction to EV3 Environment
The students will be shown the basics of handling the Lego Mindstorms EV3 environment: Relevant blocks and their uses, how they relate to universal coding principles, and the manner in which the motors perform would be examples of this.
4. Simulator Programming
After the introduction, students are expected to program the simulation. The program in its initial state would be programmed to start at a low power level, to allow students to see the effects of a simulated earthquake at a low magnitude. The students would then increase the power in the program to represent higher magnitudes for testing purposes.
5. Increase the magnitude with loops
The students, after testing the stability of their buildings at the initial magnitude, should modify the program to incorporate a loop in order to iterate, and write down predictions for whether their buildings will withstand a test at this higher magnitude.

Note:
The motors used for the simulator can have slight variances, possibly causing small fluctuations in the results for each group.

EXPLANATION

- Students will explain their process, difficulties, and strengths in creating the robot.
- **Major discussions**
  It's important to allow teams to compare their designs, so that they can see the differences in effectiveness between different types of structures. Other important questions for students to consider, both when looking at their own buildings and the buildings of other teams, are:
- What are the advantages and disadvantages of the structure?
- Does the building appear to be capable of withstanding the simulation at its current (or higher) powers? What aspects of the design would allow it to do so? What aspects could be improved?

- Which design shapes seem to be most effective for structural integrity? Why?

EXTENSION (inquiry approach)

1. Change the height.
After students get an understanding of the earthquake simulator, they will be instructed to build their own buildings with their goal of having their buildings withstand as many levels of magnitude as possible. Students will design buildings of different heights. They will then compare the buildings, to see which ones are able to withstand the most levels of magnitude. The goal is to have students discover that buildings with smaller heights are able to withstand more magnitude than buildings that are taller.

2. Change the width of the base.
Students will be instructed to use the materials provided to create buildings with different bases (narrow or wide) while maintaining the height the same. They will then test the buildings with the earthquake simulator. After testing their findings, they will record their quantitative and qualitative data. The goal is to have the students discover that buildings with wider bases are able to resist higher magnitudes than buildings with narrow bases.

3. Change buildings.
After the students have come up with both of their discoveries, they will be instructed to try to build the tallest building that can withstand a level 8 magnitude earthquake. During this time, students will use their knowledge acquired to explore more structures.

EVALUATION

We will assess their knowledge by using a pre and post survey that will indicate what they have learned.
Mention about the CT rubric here too.

a. Science content: Assess their knowledge (learning) about earthquakes
b. Robotics: Assess their computational thinking skills using the CT rubric (attached).

- Teacher will ask students what computational skills they found themselves using throughout the entire experiment.
- Then teacher will ask students to pair up with their elbow partner to discuss the computational thinking they used.

Resources
LEGO Education. (n.d.). Robust Structures - WeDo 2.0 Science - Lesson Plans - LEGO Education. Retrieved June 20, 2018, from https://education.lego.com/en-us/lessons/wedo-2-science/robust-structures
Internet resources:

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A. Computational Thinking Rubric

\ Quality Criteria \	No/Limited Proficiency (1 pt.)	Some Proficiency (2 pts.)	Proficiency (3 pts.)	High Proficiency (4 pts.)
Decomposition of a problem into smaller, more manageable parts	Not able to break down the problem	Recognizes some parts of the problem but unable to identify key contributing components	Identifies the key components that contribute to the problem	Identifies the key components that contribute to the problem and describes their significance
Ability to manipulate variables/parameters for desired result	Unable to differentiate between different variables/parameters or determine their effect upon the model	Understands significance of variables/parameters, but cannot properly change them to cause variations in the model	Has good grasp of significance of variables/parameters; is able to manipulate models accordingly after initial instruction	Has excellent grasp of variables/parameters; is able to change models correctly with little guidance
Analyze and interpret program output or data	Unable to describe program output or data	Describes program output or data, but incorrectly interprets the meaning	Correctly interprets the meaning of the program output or data	Correctly interprets the meaning of the program output or data and draws conclusions within the context of the program's limitations
Use algorithmic thinking to modify or construct computer code	Cannot develop steps to modify or construct computer code	Begins to develop steps to modify or construct computer code, but some steps are missing or not in a logical order	Series of steps to modify or construct computer code is complete and in logical order	Series of steps to modify or construct computer code is complete, in logical order, and efficient
Generalize to another problem or discipline	Cannot conceive of how the program could be transferred to address another problem	Relates program's problem-solving process to another context, but with flawed logic	Logically describes a broader application of the program's problem-solving process to address another problem	Logically describes broader applications of the program's problem solving process to address problems in multiple disciplines

B. Science learning rubric (you will create the science content rubric in the class)

Lesson plan created by: Erika Lozada and Jessica Marie Beltran, and Dr. Hanna Kim. In support with Adam Erbacher and Dr. Rachel Adler

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