Advanced Manufacturing & Prototyping Integrated to Unlock Potential

Earth Science Experimental Design (6EDS)

"*Molten Madness*"

Lava Challenge

Module Description	Students engage as earth scientists to help a small town that is adjacent to a volcano develop evacuation plans in the event of an eruption. Students develop a procedure to determine how long it takes lava to flow across the landscape, modeling with dish soap. The students use a scale model to investigate lava flow rate. They iteratively use histograms and work together to develop a procedure that controls variables and reduces error. The module covers some basic concepts regarding volcanoes, lava, and igneous rock formation, seeding further exploration of GPS standards later in the semester or year. *This module features the work of Georgia Institute of Technology Earth & Atmospheric Sciences faculty working with volcanoes.*	
Related Georgia Performance Standards	***S6E5.*** *Obtain, evaluate, and communicate information to show how Earth's surface is formed.* *f. Construct an explanation of how the movement of lithospheric plates, called plate tectonics, can cause major geologic events such as earthquakes and volcanic eruptions.*	
Module Timeline	**50-minute class periods:** 4 days Day 1: Section 1, 2 Day 2: Section 2 Day 3: Section 3,4 Day 4: Section 4	**90 minute blocks:** 3 days Day 1: Sections 1, 2 Day 2: Section 3, 4 Day 3: Section 4
Documents Included in the Download	**<u>Student Materials Folder</u>** • Student Edition *(recommended to be printed double sided)* • Student Worksheet Packet *(recommended to be printed double sided)* **<u>Teacher Materials Folder</u>** • Materials List • Annotated Teacher's Edition • Teacher Preparation Guide • Videos	

5E Stage	Student Activities How will students engage actively in the three dimensions throughout the lesson?	Teacher Activities How will the teacher facilitate and monitor student learning throughout the lesson?
Engage How does the lesson capture student interest, activate prior knowledge, and connect to a complex question, global issue, or real-world problem?	• Students are introduced to the challenge (helping a company determine the best way to measure lava flow on land in order to help towns develop evacuation plans) and the reasons for using a model with their investigation *(1.1,1.2)*	• Guide students through text to check for understanding • Discuss the importance of the challenge and determining a lava flow model based on the video report • Discuss the need to using models to represent real-life situations
Explore How does the lesson allow students to develop a common base of experiences by actively investigating the phenomenon or problem?	• Students plan their investigation and write a procedure for carrying it out *(2.1,3.2)* • Students follow their procedure and record data from their trials *(2.2,4.1)* • Students share their data with the class and record all data on a histogram *(2.3,4.2)*	• Review materials available for use and model constraints with students. • When writing class procedure, as you guide students focus on what variables need to be controlled. • Allow 10 minutes for students to run investigations and take note of students changing their experiment in-between trials. • Record groups' data on a class histogram that is projected so students can record it.
Explain How does the lesson allow students to develop, share, critique, and revise their own explanations before connecting those to accepted scientific explanations and terminology?	• Students analyze the histogram data, comparing the distribution of data to the procedure that was followed. *(2.4,2.5,4.3)* • Students discuss the procedural differences between groups and the need for sound procedures and variable control in order to collect consistent data *(3.1,3.2, 3.3)*	• Lead a class discussion about the distribution of data and how the individual procedures impacted the variation. Discuss why a large spread of data is evidence of unreliable data. • Lead a class discussion comparing the 2 histograms and how the spread of data has changed and whether there is a need for a 3rd investigation
Elaborate How does the lesson allow students to extend their conceptual understanding of the three dimensions through opportunities to apply knowledge, skills, and abilities in new experiences?	• Students will write a letter to a neighboring town council explaining what they have learned about the need for writing/following good procedures *(4.4)*	• Letter is scaffolded for students but remind them to include details of the variables they had to control and why they had to do that. How did the class data change from the first procedure to the last? Why did it change that way?
Evaluate How does the lesson—through both formative assessments embedded throughout the lesson and a summative assessment that might coincide with the elaborate phase—make visible students' thinking and their ability to use practices with core ideas and crosscutting concepts to make sense of phenomena and/or to design solutions?	**Formative:** Ongoing questioning and discussion *(all sections)* Investigation Sheet 1 (*2.1,2.2)* Results Graph 1 *(2.3)* Investigation Sheet 2 *(4.1)* Results Graph 2 *(4.2)* **Summative:** Town Council Sheet *(4.4)*	

	1.1	1.2	2.1	2.2	2.3	2.4	2.5	3.1	3.2	3.3	4.1	4.2	4.3	4.4
Engage														
Explore														
Explain														
Elaborate														
Evaluate														

Section 1 – The Lava Flow Challenge *(25 minutes)*

The focus of Section 1 is to introduce students to the Lava Flow Challenge. Students will learn that they will be working as a team to help a company determine the best way to measure the flow of lava on land in order to help towns near volcanoes develop evacuation plans. In order to complete this challenge, students will need to demonstrate that they can measure lava flow accurately by using a model. Through a class discussion, students will understand how models can stand in for actual events, processes, and situations. They will then answer the question," What are some other models that scientists use to investigate real life situations? In addition to the challenge information, background information defining volcanoes, magma, and lava is provided in the text for the students.

Preparation

Materials	Student Pages
• Video #1: CNN Lava	• None
Prep the Day Before: Review text and videos.	

Planning

GPS	***S6E5.*** *Obtain, evaluate, and communicate information to show how Earth's surface is formed. Construct an explanation of how the movement of lithospheric plates, called plate tectonics, can cause major geologic events such as earthquakes and volcanic eruptions.*
NGSS	**Performance Expectation:** **MS-ETS-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.* **Disciplinary Core Idea: ETS1.A** *Defining and Delimiting Engineering Problems* **Practice:** *Asking Questions and Defining Problems*

Key Terms and Concepts	Essential Questions	Assessment and Grading Opportunities
• Lava • Volcanoes • Model	• How do scientists solve problems?	• Discussion Questions: **Participation**

Section 2 – Investigate Lava Flow Challenge *(50 minutes)*

Students (in pairs) design and run a procedure to determine how fast lava flows over a landscape. The design of the procedure is constrained by the criteria and constraints identified in the previous section. When the results are graphed, students see a large range of results. This wide range indicates that their results are unreliable. Through a discussion, students realize that their procedures were very inconsistent which led to unreliable results. Students see the need for uniform procedures and measurements, and for collaboration and communication to confirm the reliability of results in scientific investigations.

Preparation

Materials	Student Pages
• Plastic Plates • Model Lava (dish soap) • Stopwatch • Ruler • Paper Towels	• Lava Investigation Sheet • Lava Flow Results Graph
Prep the Day Before: Sort materials by group; Download class histogram on computer for projection; Perform the investigation as practice	

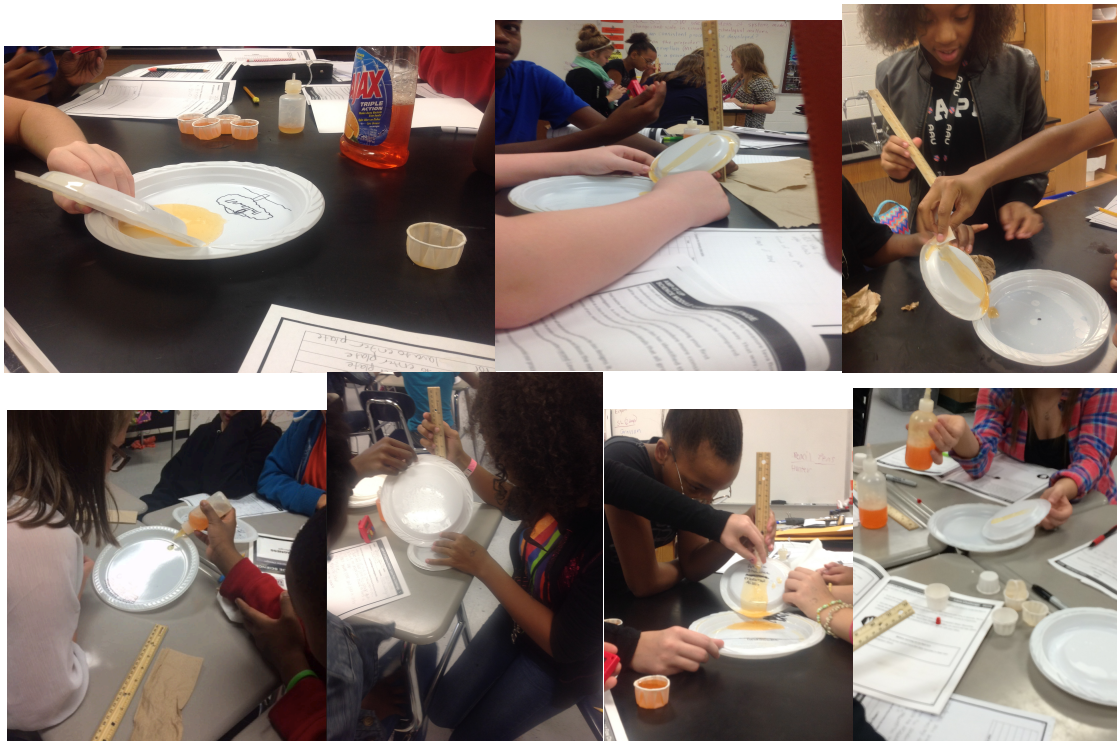
Planning

GPS	***S6E5.*** *Obtain, evaluate, and communicate information to show how Earth's surface is formed. Construct an explanation of how the movement of lithospheric plates, called plate tectonics, can cause major geologic events such as earthquakes and volcanic eruptions.*
NGSS	**Performance Expectation:** **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.* **MS-ETS1-4:** *Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.* **Disciplinary Core Idea: ETS1.B** *Developing Possible Solutions* **Practice:** *Analyzing and Interpreting Data, Developing and Using Models*

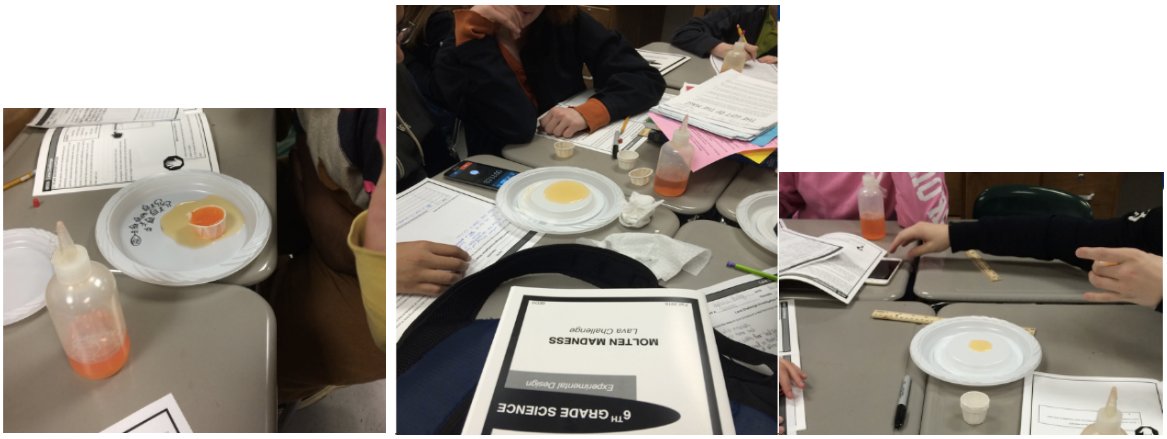
Key Terms and Concepts	Essential Questions	Assessment and Grading Opportunities
• Model • Procedure	• How can consistent procedures be developed?	• Procedure and Data Collection: **Formative** • Student histograms: **Formative** • Class Discussion Questions: **Participation**

Section 2 – Investigate Lava Flow Challenge – Setup Photos

In order for the lava (dish soap) to flow, students need to hold the plate on an angle and time how long it takes for the soap to flow from the starting point to the end point. These photos show some examples of how students set up their models- *note* you <u>do not</u> need a second plate to complete the activity.



Examples of what you don't want to see. In these photos students set up their models to represent a volcano- not a slope- to measure the flow of lava. They won't be able to time the flow because there is no flow.



Section 3 – Redesign Your Investigation *(35 minutes)*

Students identify factors in their procedures that led to inconsistent results, and then design a more precise class procedure to control these factors. They design a class procedure that is detailed and replicable, controlling each factor they identified. Students reflect on their new procedure by comparing it to the original procedure and they see how their ability to plan an investigation has improved.

Preparation

Materials	Student Pages
• Copy of Histogram from Section 2	• Lava Investigation Sheet
Prep the Day Before: Review the Class Histogram from Section 2.	

Planning

GPS	***S6E5.*** *Obtain, evaluate, and communicate information to show how Earth's surface is formed. Construct an explanation of how the movement of lithospheric plates, called plate tectonics, can cause major geologic events such as earthquakes and volcanic eruptions.*
NGSS	**Performance Expectation:** **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.* **MS-ETS1-4:** *Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.* **Disciplinary Core Idea: ETS1.B** *Developing Possible Solutions* **Practice:** *Analyzing and Interpreting Data, Developing and Using Models*

Key Terms and Concepts	Essential Questions	Assessment and Grading Opportunities
• Standardized Procedures • Histogram • Variation • Data • Consistency	• How can consistent procedures be developed?	• Lava Investigation Sheet (Revised Procedure): **Formative** • Class Discussion Questions: **Participation**

Section 4 – Investigate Lava Flow with New Procedure *(45 minutes)*

Students run their revised lava flow procedure and collect data, which they will share on a class histogram. Comparing the spread of data on the new histogram to the previous one in Section 2, will allow the class to evaluate their new procedure and determine if the class results are reliable. If the students determine that their procedure is still not precise enough, they should review and standardize the procedure again and run the investigation a third time. If the data is clustered on the histogram, students can determine that they have evidence to show that they have developed a precise and standard procedure that can accurately and repeatedly measure lava flow. Students should review the final section summary and understand that well designed procedures control variables to reduce error.

Preparation

Materials	Student Pages
• Plastic Plates • Model Lava (dish soap) • Stopwatch • Ruler • Paper Towels	• Lava Investigation Sheet • Lava Flow Results Chart • Town Council Letter Sheet
Prep the Day Before: Sort materials by group; Download blank class histogram along with class histogram from Section 2 on computer for projection.	

Planning

GPS	***S6E5.*** *Obtain, evaluate, and communicate information to show how Earth's surface is formed. Construct an explanation of how the movement of lithospheric plates, called plate tectonics, can cause major geologic events such as earthquakes and volcanic eruptions.*
NGSS	**Performance Expectation:** **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.* **MS-ETS1-4:** *Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.* **Disciplinary Core Idea: ETS1.B** *Developing Possible Solutions* **Practice:** *Analyzing and Interpreting Data, Developing and Using Models*

Key Terms and Concepts	Essential Questions	Assessment and Grading Opportunities
• Standardized Procedures • Histogram • Variation • Consistency • Variable • Error • Controls (controlled variable)	• How can consistent procedures be developed?	• Lava Investigation Sheet: **Formative** • Lava Flow Results Graph: **Formative** • Town Council Letter Sheet:**Summative**