WEST VIRGINIA
DEPARTMENT OF EDUCATION

MATHEMATICS

GRADE 7

Hot Sauce!

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Task Title: Hot Sauce!
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Quarter: 2

Rationale for Lesson and Associated Tasks

Wilbur Davis, a professional taste-tester, is making his debut as a hot sauce tester for the Screamin' Hot Sauce Company. Each hot sauce has a pre-determined rating, as set by the company. Mr. Davis is to rate his perceived hotness of each sauce on a scale of 1 to 100. Jeanette and Marty, employees of the hot sauce company, are thinking the perceived heat rating will be proportional to the pre-determined heat rating.

The Screamin' Hot Sauce lesson and associated tasks provide students with opportunities to compare unit rates using tables and graphs, analyze relationships, and use equations to represent proportional relationships in a real-life scenario. This task also requires students to seek understanding, analyze information, and look for patterns to determine whether two quantities are in a proportional relationship.

Lesson and Associated Tasks Overview

Hot Sauce! Lesson Plan* (click here)
**Download and Review the Detailed Lesson Plan*

For Grade 7 students, this lesson and associated tasks may best serve as an inquiry style introduction to proportional versus non-proportional relationships after students have learned to determine unit rates to compare two different quantities. Students learn that unit rates are best for comparing two different quantities. The task can serve to connect students' prior knowledge regarding unit to proportional relationships represented in tables and on a graph.

This lesson and associated tasks are scheduled to be completed over 4 class periods per the suggested sequence. The following is an overview. Detailed plans are provided in the Implementation Phase. *Important Note: Test Trainer Pro, a for-purchase product, activities are not included or deemed necessary for the completion of this lesson and associated tasks.*

Day 1

- Introduce the *Hot Sauce! Immersion* video to students (whole class)
- Provide students with the *Hot Sauce! Data Artifact 1* (small groups determine ratios and patterns, graph data, and consider proportionality)
- View the *Hot Sauce! Resolution* video with students (whole class)
- Review proportional relationships using tables and graphs

Day 2

- Begin with the *Hot Sauce! Simulation Trainer* video (whole class)
- Provide students with the *Hot Sauce! Page 1 of 2* (small groups—complete and review)
- Play *Tutorial Video*, to show a worked example from the Practice Printable. (whole class)
- Provide students with the *Hot Sauce! Page 2 of 2* (small groups—complete problem 1)

Day 3

- Complete Clicker Quiz (small groups)
- Initiate Student Reflection

Day 4

- Complete Student Reflection (small groups)
- Gallery Walk using the I Wonder…I Notice Protocol

West Virginia College- and Career-Readiness State Standard

M.7.2

Recognize and represent proportional relationships between quantities.

a. Decide whether two quantities are in a proportional relationship (e.g., by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin).
b. Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams and verbal descriptions of proportional relationships.
c. Represent proportional relationships by equations. (e.g., If total cost *t* is proportional to the number *n* of items purchased at a constant price *p*, the relationship between the total cost and the number of items can be expressed as $t = pn$.)
d. Explain what a point (x,y) on the graph of a proportional relationship means in terms of the situation. Focus special attention on the points (0,0) and (1,*r*) where *r* is the unit rate.

Mathematical Habits of Mind (MHM)

*While several MHM are listed, the MHM in bold font is the focus of the lesson and associated tasks.

MHM1. Make sense of problems and persevere in solving them.

MHM3. Construct viable arguments and critique the reasoning of others.

MHM7. Make use of structure

Mathematics Teaching Practices to Support Student Growth

- Implement tasks that promote reasoning and problem solving
- Facilitate meaningful mathematical discourse.
- Support productive struggle in learning mathematics.

Essential Understandings

- Proportional relationships exist between two variables that vary directly with each other when two variables have a constant ratio between them
- If a table is displaying a proportional relationship, there will be a constant relationship between corresponding terms of the two variables.
- If a graph is displaying a proportional relationship, then the line formed by the corresponding terms of the two variables will always go through the origin (0,0)

Set-up Phase

1. Become an Expert Regarding All Lesson and Associated Task Content

It is essential that you, the teacher, become very familiar with all *Hot Sauce!* materials (e.g. "Hot Sauce" Lesson, Lesson Plan, videos (4), student handouts (3), and the clicker quiz set-up and completion). This lesson comes with many associated tasks, the use of each task may vary class to class depending on the time frame available for the lesson, and the student levels of engagement and understanding.

Reviewing, analyzing, and completing all tasks prior to the implementation with students is imperative to the success of this lesson.
Important Note: Test Trainer Pro, a for-purchase product, activities are not included or deemed necessary for the completion of this lesson and associated tasks.

2. Establish Small Groups
The "Hot Sauce!" tasks promote both individual and small group thinking. Students will explore their thoughts about patterns in proportional relationships and contribute to meaningful conversations about proportional relations, unit rates, tables, and graphical displays while working in small groups.

Skill levels, leadership skills, and personalities are all considered when creating small (e.g. three students) groups. Small group collaboration works best when students have been provided previous opportunities to work together on a regular basis. Through weeks of teacher observation and making note of leadership skills, personalities, the ability to take criticism, to question, and think deeply about a task or problem will prove to be extremely helpful when creating small groups for this lesson and associated tasks. When creating the groups, all these factors help to eliminate the potential situation in which one student takes the lead and makes the decisions for the group. In this scenario, one student is gaining all the benefits of the task, while others do not. If a student is not engaged in conversation, this lesson and associated tasks will not be beneficial in helping all students to have meaningful discussions about the mathematics involved nor in analyzing the relationships inherent to the tasks. Students will be working both individually and together when placed in small groups (e.g. three students) to complete this lesson and associated tasks.

3. Develop Open-Ended Questions
Teachers should create a list of open-ended questions designed to support and scaffold the lesson and associated tasks for their students. These questions should purposefully direct students towards provided information, previously learned content, and similarities and differences in their work versus group members or video content. Some questions might include:

- What are we trying to determine?
- When using the information provided, what are we comparing?
- What pattern(s) do we see?
- How can we compare or represent different quantities?
- What did you do that was similar? Different?
- Is there a strategy that is more efficient? Why or why not?

*Additional questions are provided in the Lesson Guide as well.

4. Gather Materials

- Computer and presentation device (required for teacher usage)
- Internet access (test all videos and the clicker quiz prior to implementation with students)
- Calculators (one per student)
- Chart Paper (plain and grid), interactive presentation board or whiteboard
- Graph Paper for students
- Videos (Online): *Hot Sauce! Immersion* video, *Hot Sauce! Resolution* video, *Hot Sauce! Simulation Trainer* video, *Tutorial Video* (Test all videos prior to implementation with students)
- Handouts: *Hot Sauce! Data Artifact 1, Hot Sauce! Page 1and 2 (provide a copy of each handout for each student)*

- Clicker Quiz (Test all the clickers prior to implementation with students)
- Desmos (optional)
- White Construction paper (large) and colored pencils

5. Anticipated Common Student Misconceptions

- Students may not realize that even if data passes through (0,0) the point may not appear in a table.
- Students assume any line passing through (0,0) represents a proportional relationship.

Explore Phase

Prior to teaching this lesson and the associated activities, the following content should be reviewed (e.g. as "bell ringers" one week prior to the introduction of this lesson):
Generate a set of ordered pairs using a rule which is stated in verbal, algebraic, or table form; generate a sequence given a rule in verbal or algebraic form.

1. Given a list of ordered pairs in a table or graph, identify either verbally or algebraically the rule used to generate and record the results.
2. Locate points in all quadrants of the coordinate plane using ordered pairs in number and word problems.
3. Given a list of ordered pairs in a table or graph, identify either verbally or algebraically the rule used to generate and record the results.
4. Given a proportional relationship represented by tables, graphs, models, or algebraic or verbal descriptions, identify the unit rate (constant of proportionality).
5. **IMPORTANT:** Teachers should complete page 5 and page 6 (lesson plan) with students prior to beginning this lesson and associated activities. (Hot Sauce! Lesson Plan* (click here))

Prior Instruction/Knowledge:

During grade six, student's prior understanding of and skill with multiplication, division, and fractions contributed to their study of ratios and proportional relationships, unit rates, and percentages. During grade seven, students will develop an understanding and application of proportional relationships. Students will use ratios in cases that involve pairs of rational numbers and compute associated rates. Students will identify unit rates in representations of proportional relationships and work with equations in two variables to represent and analyze proportional relationships in the context of real-world problems.

Please review the following:

Educators Guide for Mathematics: Grade 6 (pages 4-17, pdf 6-19) (click here)
Educators Guide for Mathematics: Grade 7 (pages 4-14, pdf 6-16) (click here)

Prerequisite Skills

- Generate a set of ordered pairs using a rule which is stated in verbal, algebraic, or table form; generate a sequence given a rule in verbal or algebraic form.
- Given a list of ordered pairs in a table or graph, identify either verbally or algebraically the rule used to generate and record the results.
- Locate points in all quadrants of the coordinate plane using ordered pairs in number and word problems.

- Given a list of ordered pairs in a table or graph, identify either verbally or algebraically the rule used to generate and record the results.
- Given a proportional relationship represented by tables, graphs, models, or algebraic or verbal descriptions, identify the unit rate (constant of proportionality).

Supporting Skills

- Evaluate algebraic expressions in number and word problems.
- Use ordered pairs derived from tables, algebraic rules, or verbal descriptions to graph linear functions.
- Identify linear and nonlinear relationships in data sets.

Impending Skills

- Interpret and compare properties of linear functions, graphs, and equations.
- Graphically solve systems of linear equations.
- Determine the effects of changes in slope and/or intercepts on graphs and equations of lines.
- Write the equation of and graph linear relationships given the slope and one point on the line.
- Write the equation of and graph linear relationships given the slope and y-intercept.
- Convert between different representations of relations and functions using tables, the coordinate plane, and algebraic or verbal statements.

Source: *The Quantile Framework® for Mathematics - MetaMetrics Inc.*

Implementation Phase

Day 1

- Introduce the *Hot Sauce! Immersion* video to students (whole class)
- Provide students with the *Hot Sauce! Data Artifact 1* handout (small groups determine ratios and patterns, graph data, and consider proportionality)
- View the *Hot Sauce! Resolution* video with students (whole class)
- Review proportional relationships using tables and graphs

Day 1 Teacher Notes:

To introduce this first task, briefly explain the goal or objective – determine what information is needed for you (students) to respond to the question, "Is Mr. Davis' heat rating proportional to the Scoville heat rating for their company's hot sauces? "

1. Introduce (play) the *Hot Sauce! Immersion* video for all students to view as a whole-class activity even though students will be sitting with their small groups.
2. Upon the conclusion of the *Hot Sauce! Immersion* video, ask the student groups, each group working as a team, to identify 6 facts from the video. Ask student groups to report out 1 fact from the video without repeating a fact provided by another group. (Record answers)
3. Provide each student with the Hot Sauce! Artifact 1 paper.
4. Have student groups work together to answer the following questions with regards to Hot Sauce! Artifact I: What information has been presented on Hot Sauce! Artifact I and what do they need to know to answer the question, "Is Mr. Davis' heat rating proportional to the Scoville heat rating for their company's hot sauces? "

- Ask each small group to respond to the first question:
  What information has been presented on Hot Sauce! Artifact I? (Ask for 1 answer per group until all groups are in agreement that they have answered the question thoroughly. Record answers.)
- Ask each small group to respond to the second question:
  What do we need to know to answer the question, "Is Mr. Davis' heat rating proportional to the Scoville heat rating for their company's hot sauces?" (Ask for 1 answer per group until all groups are in agreement that they have answered the question thoroughly. Record answers.

5. Replay the *Hot Sauce! Immersion* video.
6. Provide each small group a copy of the following questions with respect to the information provided by the *Hot Sauce! Immersion* video and the Hot Sauce! Artifact 1.
   Ask students to record answers to the questions on the back of their individual Hot Sauce! Artifact 1 papers.
   Q #1: What pattern(s) do you notice in the Scoville heat rating?
   Q #2: What pattern(s) do you notice in Mr. Davis' human perceived heat-rating?
   Q #3: What does it mean for two variables to be proportional?
   What is meant by two variables?
   What makes variables proportional?
   Q #4: As the Scoville rating increases, how does Mr. Davis' heat rating change? By how much?
   Q #5: What would the data look like on a graph?

   Observe students at work. Avoid confirmation of a solution. Look for opportunities to clarify vocabulary, identify student strategies, and take note of student work samples to be shared with the class when small groups report out their answers to Q #1-Q #5. Use the information below to guide students' responses and to develop clarifying questions.
   Q #1: What pattern(s) do you notice in the Scoville heat rating?
   A #1: the Scoville heat rating begins at 0 for the 1st sauce and increases by 50,000 Scoville units for each of the following 4 sauces.

   Q #2: What pattern(s) do you notice in Mr. Davis' human perceived heat-rating?
   A #1: Mr. Davis' heat ratings are 0, 10, 25, 45, 75 with a difference between hot sauce ratings of 10, 15, 20, 30. No pattern emerges.

   Q #3: What does it mean for two variables to be proportional?
   A #3: What is meant by two variables? Think-→0:0 (1st set of variables), 10:50,000 (2nd set of variables), 25:100,000 (3rd set of variables), 45:150,000 (4th set of variables), 75:200,000 (5th set of variables)

   What makes variables proportional? Variables are in proportion when the constant of proportionality (constant ratio) is the same.
   10:50,000 (2nd set of variables) = 0.0002
   25:100,000 (3rd set of variables) = 0.00025
   45:150,000 (4th set of variables) = 0.0003
   75:200,000 (5th set of variables) = 0. 000375
   The variables are not proportional as the constant of proportionality (constant ratio) is not the same.

Q #4: As the Scoville rating increases, how does Mr. Davis' heat rating change? By how much?
A #4: Mr. Davis's heat ratings changes are: Mr. Davis' heat ratings are 0, 10, 25, 45, 75 with a difference between ratings of 10, 15, 20, 30. No pattern emerges.

Q #5: What would the data look like on a graph?
A #5: Graph this information (e.g. (0,0) (10, 50,000), (25, 100,000), (45,1 50,000), (75, 200,000) The graph will not be a line. It will be a curve with the origin of (0,0).

Q #6: What information do we need to determine if there is there a constant ratio between the two types? (In other words, how do we determine if the Human Perceived Heat Rating compared to the Scoville Heat Rating for the 5 hot sauces is a constant ratio?)
A #6: The constant of proportionality (constant ratio) will be the same between sets of variables and the graph of the variables will be a line.

Day 2

- Begin with the *Hot Sauce! Simulation Trainer* video (whole class)
- Provide students with the *Hot Sauce! Page 1 of 2* (small groups—complete and review)
- Play *Tutorial Video*, to show a worked example from the Practice Printable. (whole class)
- Provide students with the *Hot Sauce! Page 2 of 2* (small groups—complete problem 1

Day 2 Teacher Notes:

1. Begin with the *Hot Sauce! Simulation Trainer* video Part I (Whole class review of Day #1 up to the point where questions begin.)
   The *Hot Sauce! Simulation Trainer* video starts by reviewing the graphical representation of the information from the Hot Sauce! Artifact 1 (Day #1)
   Please Note: The blue line, as illustrated during the video, represents Scoville's anticipated response for the hot sauce heat levels. Scoville's anticipated results are: (0,0) (10, 50,000), (20, 100,000) (30,1 50,000) (40, 200,000).
   Scoville's anticipated results are proportional.
   The red line, as illustrated during the video, represents Mr. Davis' perceived response for the hot sauce heat levels. Mr. Davis' perceived results are: (0,0) (10, 50,000) (25, 100,000) (45,1 50,000) (75, 200,000).
   Mr. Davis' perceived results are not proportional. Mr. Davis' results do not form a line (even though the graph begins at (0,0) and the ratios formed by the corresponding ratings are equivalent.
2. Begin with the Hot Sauce! Simulation Trainer video Part II (This section of the video begins with problems specific to heat ratings being proportional. Ask students to complete the work to answer these problems as a small group. Provide a time limit per problem. Provide calculators to all students. Permit students to derive multiple methods to solve the problems. Monitor small groups and call upon different groups to answer and explain the problem solution as agreed to by their group.
3. Provide students with the Hot Sauce! Page 1 of 2. This task should be completed individually. Students will be required to 1) determine if the perceived heat rating is proportional to the Scoville heat rating and 2) provide mathematical justification (show the math they used) for their response. Collect student work and then have a class conversation regarding the response to the questions: Is the perceived heat rating is proportional to the Scoville heat rating? What mathematics supports your answer?

4. Return students to their small-groups. Provide students with the *Hot Sauce! Page 2 of 2*.
   Instructions:
   Review the answer key (lesson plan page 2) carefully
   Problem 1 a-h: Identify if the item is proportional or not proportional and provide a mathematical explanation for each item (a-h)
   Provide the following assistance for items e-g

e) 1.5x = y

x	y
0	
2	
4	
6	

f) y=5x + 2

x	y
0	
1	
2	
3	

g) y = 20x

x	y
0	
1	
2	
3	

Question #3a: The instructions are vague. You may wish to work with the students to complete the Part A charts—not the equations.

Day 3:

- Complete Clicker Quiz---6 problems (small groups)
- Initiate Student Reflection, Ratio, and Proportional Relationship Story Card Project

Day #3 Teacher Notes:

1. When using the Clicker Quiz with students you may decide to:
   - choose to disable virtual clickers, provide each small group with a copy of the quiz questions, survey small groups for their response (answer) to each question and then have groups with different answers defend their decisions.,—or—
   - display the quiz questions via the projection device, survey small groups for their response (answer) to each question, and then have groups with different answers defend their decisions.

   Please note: Computers or cell phones are required to use the Interactive Clicker Quiz. Follow instructions on page 10 (lesson plan). The clicker quiz may be completed using the options above.
2. Develop 8-10 ratio and proportional relationship story cards similar to Hot Sauce!, problem 3 (from Applying the Standard page 2 of 2—Workout World gym). Story cards need to provide the story and the data associated with the story.

   Example Story Card:

   Sarah wants to purchase bagels for a breakfast event. The Bagel Factory is advertising bagels for the following costs. Is this a proportional relationship?

# Bagels	1	2	6	13	19	26
Price ($)	0.75	1.50	4.50	9.00	13.50	18.00

3. Ask each small group to randomly select one story card.
4. Print and copy the Student Reflection Rubric (Page 9 Lesson Plan) and distribute to students.
5. Review (explain) the student reflection rubric with students.

6. Create, with students, a list of items to be completed by each small group similar to the list below:
    - Draw a visual representation of the story. Include a title.
    - Create a mathematical drawing (tables, graphs, equations, figures, etc.) that shows the math used in the story.
    - Write a brief narrative that describes how the math was used in the story.
    - Using an example associated with your story, create a multiple-choice question using the math concept. Circle the correct answer.
    - Each small group of students is to use the rubric to grade yourself by circling how you did in each category. Turn this in with your Student Reflection.
7. Small groups are to begin their ratio and proportional relationship story card project. Provide white construction paper and colored pencils.

Day 4:

- Complete Student Reflection (small groups)
- Gallery Walk using the I Wonder…I Notice Protocol (Lesson plan page 11)

Day #4 Teacher Notes:

1. Complete Student Reflection (small groups)
2. Organize a Gallery Walk using the I Wonder…I Notice Protocol
   Each student takes Gallery Walk (16-20 min)
   Display student small group ratio and proportional relationship story card project work on classroom walls. Assign groups with tasks focused on specific details (use the 4 components defined in the rubric). Tell groups to walk around, complete their task (≈ 8-10 min), then prepare and report brief remarks to the class with their broader "a-ha" and "why" understandings (≈ 8-10 min).

Share, Discuss, and Analyze Phase

Essential Understanding #1:

Proportional relationships exist between two variables that vary directly with each other when two variables have a constant ratio between them

Share- The lesson opens with students being presented the question," Is Mr. Davis' heat rating proportional to the Scoville heat rating for their company's hot sauces?" Upon the conclusion of the *Hot Sauce! Immersion* video, student groups, each group working as a team, are to share 6 facts from the video with the class.

Discuss- Student groups work together and discuss the following question with regards to Hot Sauce!

Q#1: With Respect to Artifact I: What information has been presented on Hot Sauce! Artifact I and what do you need to know to answer the question, "Is Mr. Davis' heat rating proportional to the Scoville heat rating for their company's hot sauces?"

Analyze- Students review, analyze, and respond to Hot Sauce! Artifact 1 data questions:

Q #1: What pattern(s) do you notice in the Scoville heat rating?

Q #2: What pattern(s) do you notice in Mr. Davis' human perceived heat-rating?

Q #3: What does it mean for two variables to be proportional?

What is meant by two variables?

What makes variables proportional?

Q #4: As the Scoville rating increases, how does Mr. Davis' heat rating change? By how much?

Q #5: What would the data look like on a graph?

Essential Understanding #2:
If a table is displaying a proportional relationship, there will be a constant relationship between corresponding terms of the two variables.
Share- Students share their discoveries from the Hot Sauce! Artifact 1 activity and examples via a class discussion in terms of the following:

What it means for two variables to be proportional? (Cite examples)
What is meant by two variables? (Cite Examples)
What makes variables proportional? (Cite Examples)
What happens as the Scoville rating increases in relationship to Mr. Davis' heat ratings?
What the data would look like on a graph.

Discuss- Student groups work together and discuss situations presented via the Hot Sauce Simulation video Part II and jointly make decisions as to whether the situations are proportional or not proportional. Students are to be encouraged to derive multiple methods to solve problem situations. Groups are to be monitored and called upon to answer and explain problem solutions as agreed to by their group.
Analyze- Students working in their small groups analyze equations with two variables, Hot Sauce! Page 2 of 2, to determine if a proportion exists/does not exist. The group develops mathematical explanations to defend their decision.

Essential Understanding #3:
If a graph is displaying a proportional relationship, then the line formed by the corresponding terms of the two variables will always go through the origin (0,0)
Share- Students share their discoveries when graphing the equations from Hot Sauce! Page 2 of 2.
Discuss- Student groups discuss proportional relationships between lines when the lines go through the origin (0.0) and when they do not go through the origin (0,0)). The discussion will be based upon the Hot Sauce! page 2 of 2 equations.
Analyze- Students working in their small groups analyze the graphs of equations with two variables, Hot Sauce! Page 2 of 2, to determine if a proportion exists/does not exist. The group then develops mathematical explanations to defend their decision regarding the lines going through the origin (0,0).

Task In Action

The video clips below provide a demonstration of the task being implemented in a classroom as it aligns with the Effective Mathematics Teaching Practice indicated. These clips should be used by the teacher to model the implementation of the task in his or her classroom.

- Establish Mathematics Goals to Focus Learning:
  - Video Clip #1
- Use and Connect Mathematical Representations:
  - Video Clip #2
- Facilitate Meaningful Mathematical Discourse:
  - Video Clip #3
- Pose Purposeful Questions:
  - Video Clip #4
- Support Productive Struggle in Learning Mathematics:
  - Video Clip #5