Rich Mathematical Task – Grade 8 – It's Your Lucky Day

Task Overview/Description/Purpose:

- Students will be presented with two bowls of jelly beans whose flavors are mixed in a prescribed way, where part of the jelly beans are not tasty. They are asked to determine which case, out of three scenarios, would give them the greatest chance of avoiding the undesirable beans.
- In this task students will explore independent and dependent events in order to develop mathematical understanding of the differences between them as well as their application to the probability of two events.
- This task is intended to explore the idea of considering the probability of two events which can be independent or dependent as an introduction to the eighth grade content.

Standards Alignment: Strand – Probability and Statistics

Primary SOL: 8.11 The student will
a) compare and contrast the probability of independent and dependent events; and
b) determine probabilities for independent and dependent events.

Related SOL (within or across grade levels/courses): 3.14, 4.13, 5.15, 7.8

Learning Intention(s):

- **Content –** I am learning about the probability of independent and dependent events.
- **Language –** I am learning how to justify and explain my thinking when determining the probability of two events.
- **Social –** I am learning to collaborate with my classmates to solve problems involving the probability of events.

Success Criteria (Evidence of Student Learning):

- I can determine whether two events are independent or dependent.
- I can compare and contrast the probability of independent and dependent events.
- I can determine the probability of two independent events.
- I can determine the probability of two dependent events.
- I can justify my thinking and explain my solutions to my classmates when solving probability problems.
- I can expand my thinking by collaborating with my classmates on a probability task.

Mathematics Process Goals

Problem Solving	• Students will apply prior knowledge in the area of probability to explore a problem which is an application of the probability of two events.
Communication and Reasoning	• Students will justify their choice in regards to which scenario should theoretically result in the best outcome.
Connections and Representations	• Students may model the scenario or represent the probability of two events in table form, as a tree diagram, or as a combination of two ratios. They will have an opportunity to connect these representations as they work towards a more efficient method to evaluate the probability of two events, regardless of whether those events are independent or dependent.

Task Pre-Planning

Approximate Length/Time Frame*:* 50 minutes

Grouping of Students: Launch will be whole class. The task will be distributed for students to work on individually for

5-10 minutes. Then, students will collaborate in small groups of the teacher's choosing to refine their strategies and/or compare strategies. Small groups should prepare a strategy to share (or multiple strategies to share) with the whole class. The teacher should alert small groups whose work she plans to share so that they will be prepared. In order to reflect and move forward, the grouping will return to whole class so that the teacher can orchestrate sharing out of strategies in an order to make connections and promote discovery of the 8.11 standard.

Materials and Technology:

- any manipulative that students might use to simulate the task,
- calculators (Desmos or handheld)

Vocabulary:

- probability
- outcomes
- sample space
- tree diagram
- Fundamental Counting Principle
- ratio
- simple events
- independent events
- dependent events

Anticipate Responses*:* See Anticipated Student Responses table columns 1 - 3

Task Implementation (Before)

Task Launch:

- As a whole class, the teacher should introduce a brainstorming session where students are instructed to provide any information they have in their "probability toolbox." Students may bring up things like:
  - measurement of chance
  - likelihood of an event
  - can be recorded as a fraction, decimal, or percent
  - range from 0 to 1 (or 0% to 100%)
  - can make a tree diagram to show possible outcomes
  - can use the Fundamental (Basic) Counting Principle to determine the number of outcomes
  - theoretical versus experimental
  - experimental probability approaches theoretical probability as more trials are introduced in an experiment
- To prevent compromising the integrity of the task, teachers should record all prior knowledge shared by students (without applauding any particular item or adding to the list themselves).
- After the brainstorming session, teachers should explain to the students that they will be participating in a task that is asking them to draw from all of their prior knowledge to answer a question.
- The class should read the task together.
- The teacher should make sure that all students understand the task at-hand and that all of the words used are clear to them as readers.
- The teacher must discourage any discussion of strategy at this point.

Task Implementation (During)

Directions for Supporting Implementation of the Task

- Monitor – Teacher will listen and observe students as they work on task and ask assessing or advancing questions (see chart on next page)
- Select – Teacher will decide which strategies or thinking that will be highlighted (after student task implementation) that will advance mathematical ideas and support student learning
- Sequence – Teacher will decide the order in which student ideas will be highlighted (after student task implementation)
- Connect – Teacher will consider ways to facilitate connections between different student responses

Suggestions For Additional Student Support

- Some students with visual-motor weaknesses may benefit from graph or lined paper to help them organize a table or tree diagram.
- Students with weaknesses in memory or who need more language support could benefit from word walls or graphic organizers to activate prior knowledge about probability.
    - For beginning EL students, consider the use of a visual word wall or reference sheet for students to use (e.g., soap, buttered popcorn, jelly bean, likelihood response options, language frames for comparing likelihood (more/less likely that …,identical)
- Post visual cues for students who need support with memory.
- Provide manipulatives such as bowls and beads to support visual-spatial-kinesthetic learning.
- Scaffold the task by asking the student to determine the probability of taking one jelly bean first.
- For students need support in justifying their thinking, you may choose to provide them with the sentence frames below.
    - What I know about the problem is…
    - My method for solving the problem was…
- For ELs with first language literacy, try to provide prompt, or parts of prompt, in their home language.
- Read the prompt aloud.
- In instruction, use motions to emphasize the undesirable reaction to soap or rotten eggs with the identical colors (act out the scenario to give context), using the language from the prompt as you do so.

Task Implementation (After)

Connecting Student Responses (From Anticipating Student Response Chart) and Closure of the Task:

- Based on the actual student responses, sequence and select particular students to present their mathematical work during class discussion.
- Connect different students' responses and connect the responses to the key mathematical ideas to bring closure to the task.
- Consider ways to ensure that each student will have an equitable opportunity to share his/her thinking during task discussion.

Teacher Reflection About Student Learning

- Student understanding of the content through the use of the process goals will be assessed with the Rich Mathematical Task Rubric.
- When this task is used to introduce the 8.11 content, students cannot be expected to perform at a proficient or advanced level in all four sections of the rubric.
- The results of this task will help the teacher assess background knowledge and give the students an opportunity to apply this knowledge to a new situation.
- Teachers may choose to revisit this same task at a later date in order to document student growth.

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Planning for Mathematical Discourse

Mathematical Task: _It's Your Lucky Day_____ Content Standard(s): _SOL 8.11 ____

Anticipated Student Response/Strategy *Provide examples of possible correct student responses along with examples of student errors/misconceptions*	**Assessing Questions – Teacher Stays to Hear Response** *Teacher questioning that allows student to explain and clarify thinking*	**Advancing Questions – Teacher Poses Question and Walks Away** *Teacher questioning that moves thinking forward*	**List of Students Providing Response** *Who? Which students used this strategy?*	**Discussion Order - sequencing student responses** • *Based on the actual student responses, sequence and select particular students to present their mathematical work during class discussion* • *Connect different students' responses and connect the responses to the key mathematical ideas.* • *Consider ways to ensure that each student will have an equitable opportunity to share his/her thinking during task discussion*
Anticipated Student Response: **Non-starter**	• What are you thinking? • Is there anything that you need me to clarify about the task?	• Can you draw a picture of the bowls of jelly beans to see if that might help? • Can you model the bowls of jelly beans to see if that helps you get started?		
Anticipated Student Response: **Student approaches each scenario as a single event (Bowl 1 twice – 3/5, Bowl 2 twice – 4/6 One from each bowl – 7/11)**	• Can you explain each of the ratios that you have recorded? • How many jelly beans do you need to draw from the bowls that Ms. Chievous has created?	• Is there a bowl that contains eleven jelly beans? • Do these ratios remain the same after you have drawn your first jelly bean from a bowl?	Student D	
Anticipated Student Response: **Student focuses on the jelly beans that are to be avoided rather than the tasty ones**	• Can you tell me what this ratio represents? • What question are you answering in this task?	• Can you draw a picture of the bowls of jelly beans and think about how it relates to the question you are answering? • What are the chances that you will select a tasty jelly bean from bowl 1?		

Anticipated Student Response/Strategy *Provide examples of possible correct student responses along with examples of student errors/misconceptions*	**Assessing Questions – Teacher Stays to Hear Response** *Teacher questioning that allows student to explain and clarify thinking*	**Advancing Questions – Teacher Poses Question and Walks Away** *Teacher questioning that moves thinking forward*	**List of Students Providing Response** *Who? Which students used this strategy?*	**Discussion Order - sequencing student responses** • *Based on the actual student responses, sequence and select particular students to present their mathematical work during class discussion* • *Connect different students' responses and connect the responses to the key mathematical ideas.* • *Consider ways to ensure that each student will have an equitable opportunity to share his/her thinking during task discussion*
Anticipated Student Response: **Student does not discriminate between independent and dependent events**	• Where did these fractions/ratios come from? • Can you explain your thinking?	• If I draw from the same bowl twice, is the probability the same both times? • Can you draw a picture or simulate the task?		
Anticipated Student Response: **Student applies Logical Reasoning** (My chances to select a tasty bean are better in bowl 2 because there are more tasty flavored ones mixed with the two junk flavors. After I take one from bowl 2, it doesn't matter whether I select from bowl 1 or bowl 2 because my chances of selecting a tasty flavor are equally likely.)	• Can you explain your thinking? • Why do you say that it doesn't matter which bowl you choose from when you select your second jelly bean? • Whose advice should you listen to? Why?	• What if the number of jelly beans in bowl 2 were different, like 4 buttered popcorn and 3 rotten egg? How would that affect your reasoning?	Student B	
Anticipated Student Response: **Student creates a Tree Diagram or Table**	• Will you tell me about this graphic organizer that you are using? • How does this help you to answer the question posed in	• Can you think of a way to come to these same conclusions without drawing this tree diagram/table?	Student C	

Anticipated Student Response/Strategy *Provide examples of possible correct student responses along with examples of student errors/misconceptions*	**Assessing Questions – Teacher Stays to Hear Response** *Teacher questioning that allows student to explain and clarify thinking*	**Advancing Questions – Teacher Poses Question and Walks Away** *Teacher questioning that moves thinking forward*	**List of Students Providing Response** *Who? Which students used this strategy?*	**Discussion Order - sequencing student responses** • *Based on the actual student responses, sequence and select particular students to present their mathematical work during class discussion* • *Connect different students' responses and connect the responses to the key mathematical ideas.* • *Consider ways to ensure that each student will have an equitable opportunity to share his/her thinking during task discussion*
	this task? • Whose advice should you take?			
Anticipated Student Response: **Student compares the ratios/fractions from each event separately (part/part or part/whole)**	• What do these fractions/ratios represent? • Why did you choose this number for your denominator?	• Which flavor of jelly beans in the bowl are we hoping to choose? • How many jelly beans are there in each bowl? • Is there a way to represent your ratios so that they reflect the probability that you will experience success on your lucky day? • If I asked you "what are the chances that you will select two tasty beans if you follow your friend's suggestion?" how would you respond?	Student A	
Anticipated Student Response: **Student determines the overall probability of two positive**	• Can you describe how you came up with the ratios/fractions that you are using?	• Can you make a graphic organizer to explain why your method works? • Can you prove that your	Student E Student F (Both of these students were revisiting the task	

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outcomes by multiplying the probabilities of each event	• Why did you decide to find the product of those two ratios/fractions? • What does the product represent?	method works?	after some classroom instruction had occurred.)	

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Name_____ Date_____

It's Your Lucky Day

J. Beans, Inc. produces two different flavor mixes at their jelly bean factory. Their most popular J. Beans are the Original Juicy Beans, but they also sell a surprisingly large quantity of their Junk Beans as well. If you look at flavor guides for these two mixtures, you will see that the Juicy Bean coconut flavor and the Junk Bean soap flavor look identical. Likewise, buttered popcorn and rotten egg look the same.

Ms. Chievous makes two bowls of jelly beans with her own unique mixture of flavors.

The tables show how many jelly beans of each flavor Ms. Chievous placed in the two bowls:

Bowl 1

Flavor	Number of Jelly Beans
Coconut	3
Soap	2

Bowl 2

Flavor	Number of Jelly Beans
Buttered Popcorn	4
Rotten Egg	2

Ms. Chievous explains that she will select the name of one student who can have two of the jelly beans from her bowls. It is your lucky day, Ms. Chievous draws your name and asks if you are willing to choose two jelly beans and eat them in front of the entire class. You accept the challenge, but are really hoping to avoid having your mouth taste like it is filled with soap or a rotten egg.

Three of your best friends give you some advice.

Susan suggests that you pick two jelly beans from bowl 1.	Todd advises you to pick both jelly beans from bowl 2.	Jamie tells you that you should pick one jelly bean from each bowl.

Think this through carefully! Ms. Chievous will have the camera rolling as you eat each jelly bean. Whose advice should you follow?

Explain your reasoning thoroughly enough to convince us that you are making the best out of your lucky day.

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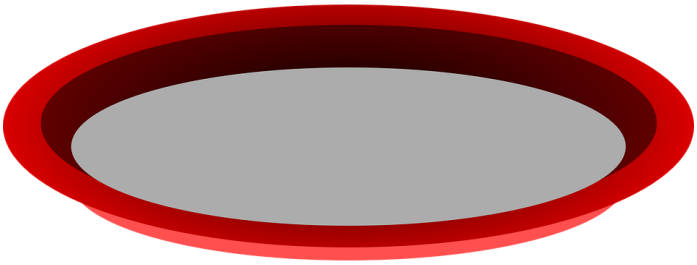
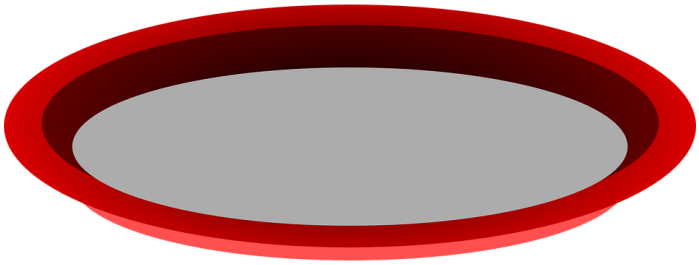
Rich Mathematical Task Rubric

	Advanced	Proficient	Developing	Emerging
Mathematical Understanding	Proficient Plus: • Uses relationships among mathematical concepts	• Demonstrates an understanding of concepts and skills associated with task • Applies mathematical concepts and skills which lead to a valid and correct solution	• Demonstrates a partial understanding of concepts and skills associated with task • Applies mathematical concepts and skills which lead to an incomplete or incorrect solution	• Demonstrates little or no understanding of concepts and skills associated with task • Applies limited mathematical concepts and skills in an attempt to find a solution or provides no solution
Problem Solving	Proficient Plus: • Problem solving strategy is efficient	• Problem solving strategy displays an understanding of the underlying mathematical concept • Produces a solution relevant to the problem and confirms the reasonableness of the solution	• Chooses a problem solving strategy that does not display an understanding of the underlying mathematical concept • Produces a solution relevant to the problem but does not confirm the reasonableness of the solution	• A problem solving strategy is not evident or is not complete • Does not produce a solution that is relevant to the problem
Communication and Reasoning	Proficient Plus: • Reasoning is organized and coherent • Consistent use of precise mathematical language and accurate use of symbolic notation	• Communicates thinking process • Demonstrates reasoning and/or justifies solution steps • Supports arguments and claims with evidence • Uses mathematical language to express ideas with precision	• Reasoning or justification of solution steps is limited or contains misconceptions • Provides limited or inconsistent evidence to support arguments and claims • Uses limited mathematical language to partially communicate thinking with some imprecision	• Provides little to no correct reasoning or justification • Does not provide evidence to support arguments and claims • Uses little or no mathematical language to communicate thinking
Representations and Connections	Proficient Plus: • Uses representations to analyze relationships and extend thinking • Uses mathematical connections to extend the solution to other mathematics or to deepen understanding	• Uses a representation or multiple representations, with accurate labels, to explore and model the problem • Makes a mathematical connection that is relevant to the context of the problem	• Uses an incomplete or limited representation to model the problem • Makes a partial mathematical connection or the connection is not relevant to the context of the problem	• Uses no representation or uses a representation that does not model the problem • Makes no mathematical connections

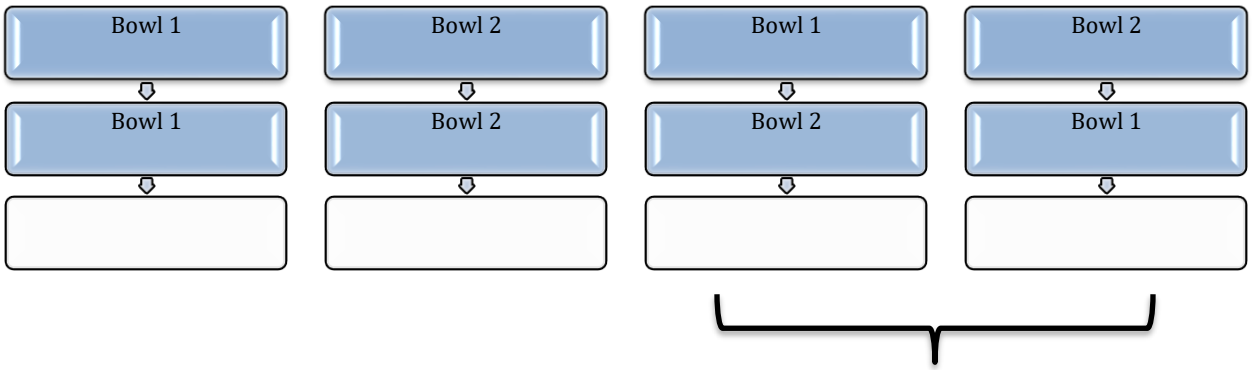
Possible Graphic Organizers



Bowl 1



Bowl 2



Susan **Jamie** **Todd**