Activity F.2: Sunken Treasures

Special Note: This is a really challenging & fun game. Complex reasoning and problem solving skills as well as knowledge of factors and common multiples are required to optimize play. It is still fun to play if all team members are not adept at all skills levels. The key is don't tell the students any more than the basic ground rules– let them figure the rest out. The first several times students play they think it is trivial. They don't use any math skills because we don't tell them to. Let them play 3 or 4 times in a row quickly so they will begin to strategize.

Learning Objectives:

1) Develop reasoning skills.

2) Identify factors.

3) Recognize common multiples and unique multiples on Zillio (for factors ≤12, and products ≤ 60).

Examples of Skills Accomplished:

1) 57 is a unique multiple of 3 for factors ≤12, products ≤ 60.

2) 28 has factors of 2, 4, and 7.

3) The only factors of 49 are 1, 7,and 49.

4) Tokens of the same color numbered 8, 16 and 40 could be multiples of 2, 4, or 8.

5) Tokens of the same color numbered 9, 21, and 42 can only be multiples of 3.

Setup:

1) Using any foam card that does not match the color of the staircase, select the tokens representing the multiples for the staircase and put them directly into the treasure trove.

2) Mix up the tokens in the treasure trove – they now have become spice jars and the staircases are spice chests with jar holders (notches) to represent maximum capacity for each chest.

Hints: You can't let students who are going to play the game know which foam card was used to generate which multiples.

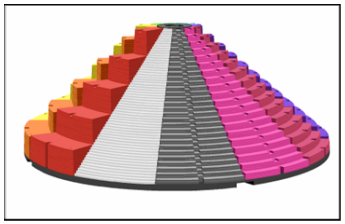
1) You may assign this task to students who are going to help you be the pirate

2) You may want to keep a set of foam cards with the multiples in place but turned blank side up to speed up this process.

Maximum Number of Players for Small Group Activities: 4

Players Positions: Standing

Grey foam logs In:



Game Objective: Tell the players that you are a pirate and they are a team of spice merchants. A ship carrying their cargo of jars of 11 kinds of spices has been shipwrecked. You captured the ship and will only give the jars of spices back to them that they can fit into 11 chests. They will only be profitable if they can capture at least 90% of their spices back. But being a little dastardly, you've imposed some rules:

a. Spice Merchants may talk among themselves at any time to develop the best game plan.

b. Spice Merchants must place jars in a chest each turn; they may not hold onto jars for later placement.

c. Any jar not placed in a chest, immediately becomes the pirate's permanent property Display it prominently for all to see.

d. Any empty chest can hold any color of spice, but any chest can hold only one color of spice.

e. Each chest has a different capacity of jar holders (notched steps only). Once the capacity of the chest has been exceeded, all subsequent jars of that color spice are forfeited to the pirate.

2) Begin play. Each turn (until there is at least one spice jar in each chest), each merchant draws a spice jar from the treasure trove. Talking among themselves, they may develop a strategy of where to place the jars. Then all merchants put their spices in an unoccupied holder (notch) in the chest, <u>number side up</u>.

3) After every chest has at least one spice jar in it, spice merchants no longer need to take turns – they should fill the chests as quickly as possible, following the color placement. You can help also to speed up this step.

4) Any time the pirate sees a chest with more than one color spice in it he/she gets to capture all the jars in that chest. Leave the captured jars number side up on the tabletop.

5) After all jars have been claimed (by either the spice merchants or the

Hints: **<u>But Don't Tell the Merchants!!</u>**

To place jars optimally, the merchants will need to pay attention to clues provided by the numbers on the tokens but don't tell them – let them develop the reasoning and problem solving skills to figure it out. To begin with they don't pay any attention to the numbers (because we haven't told them to). The key to winning will be to use factoring skills, and identify common multiples, and use complex reasoning for proper placement. There will be a one-to-one match of spices to notches if they can figure out which color of tokens should be associated with which staircase. Once they figure this out they will win. Some sacrifices early allow for the best decisions. See the special note below for some examples of reasoning required.

You will be able to see how well they can problem solve. If necessary give them hints but don't give them

pirate), spice merchants need to calculate whether they are profitable; they must have recaptured at least 90% of the total.	instructions.
Activities: 6) **<u>Don't tell the merchants</u>** specifically how to calculate the answer. Instead review what a percentage means.	There are 124 notched steps so they must have captured at least 112 (the pirate no more than 12) for them to be profitable.

Special Note: Plan to allow spice merchants to play 3 or 4 quick games in a row. After each chest has a color in it, everybody (including you) works quickly to get the remaining spices in chests.

1) The first time they play, they will probably use no math skills, because the dastardly pirate didn't tell them to. They will think the game is so easy, until about half way through when the pirate starts capturing a lot of spices. Unless they happened to guess right and put the multiples of 2 on the 2x staircase, they will only capture 50%-70% of the spices.

2) The second or third time they'll recognize which color has the greatest frequency and agree to put it on the 2x staircase, but their reasoning won't be based on numbers yet.

3) Over time they will begin to use numbers as a clue to guide them. They can observe both tokens in the chests and ones you've captured to begin to use sophisticated reasoning to optimize placement. When they actually use multiples, factoring, process of elimination, and mental "decision trees", they will win.

4) Examples of reasoning required:
   - If they draw a jar Color A numbered 49 they know all of the Color A should be put on the 7x staircase because 7 is the only factor (besides 1, and itself) of 49. Therefore the 7x staircase will have the maximum capacity needed for the Color A spices.

   - If they draw a color B numbered 30 early in the game they may be better off letting the pirate capture the spice and wait until they get other color clues to decide what multiples are represented by Color B (possibilities: 30 can be factored by 2, 3, 5, 6, or 10). A mistake can be costly; if they place Color B on the 10x staircase but it actually belongs on the 2x staircase, they will only have room for 6 jars but they need room for 30 so they would have to sacrifice 24 jars.

   - If they draw a second Color B token numbered 40, they need to determine which staircase (factor) has both a 30 and 40 on it. The number 30 can be factored by (2, 3, 5, 6, or 10), however 40 can not be factored 3 or 6 so the only possibilties that remain for Color B are 2, 5 or 10. Comparison to colors of other known numbers may guide

their choices. For example if they can see the number 25 whether or not it is in the right place or even if it has been captured, and it is a different color, they can now rule out multiples of 5 for Color B.

- Sometimes it might be best for them to purposefully place two colors in the same chest to let you, the pirate, capture all the jars on that staircase rather than for them to continue down a path that requires too much sacrifice. When the chest is empty any color can be placed in it. However if want to be true to character, you can wait to capture the jars in the chest until they have had to make many more sacrifices. This makes them place a higher value on reasoning from the start and makes them less willing to leave things to chance. It is fun being the pirate!

5) Next time you setup to play a series of games, try to use a different color for multiples of 2 and 3, so they can't rely on frequency in previous games to guide them and avoid reasoning in this one. It is not as important to vary colors of the other multiples.

6) Once students become proficient in this game, enlist them as pirates to lead other games.

Observe and Assess:

1) Fluency with multiples and factoring.
2) Reasoning skills.
3) Attention to detail.
4) Problem solving skills.
5) Interpersonal skills.

Group Discussion & Review of Findings:

1) N/A

Transition to Paper:

1) N/A to allow more time to play the game.