Lesson: Factor Trees: Novice Breakout

Lesson Overview
In this lesson, students will use factor trees to find the greatest common factor of 2-digit and 3-digit numbers to decode the combinations on a locked box.

SC Standards Addressed
6.NS.4 Find common factors and multiples using two whole numbers.

a. Compute the greatest common factor (GCF) of two numbers both less than or equal to 100.

Disciplinary Literacy Strategies
Collaborative Groups

Computational Thinking
Tools:
Novice Breakout (*Physical*)

Cornerstone(s) Addressed:

- Decomposition: Students decompose when they find pairs of factors for each of the original numbers
- Pattern Recognition: Students should recognize certain combinations of factors occur and as they determine the connection between the numbers in the answers and the letters on the locks.
- Algorithmic Thinking: Students create the order for their prime factorization sentence.
- Abstraction: Students must identify the most efficient and effective solutions.

Lesson Plan
Time required: Two 45-minute classes

Focus Question(s): How can you find a GCF using factor trees and use it to crack the code?

Disciplinary Vocabulary: factor trees, greatest common factor, prime factors, lockbox, code

Materials needed:

- 5 lock boxes (*Sheffield Plastic Field Boxes are the sturdiest and at $9 a piece are the cheapest – Walmart, Amazon*)
- 5 four-letter word lock (*Lock Vertical Resettable Locks - $8 – Target, Walmart, Amazon, etc…) NOTE: Dollar Stores occasionally carry these materials for a lot less*
- 4 clues for each box (Listed at the end of this document.)
- Paper and pencils for each group

Preparation:
Place locked boxes strategically around the room. (*Locate an area where a group of students can easily observe the box and its lock; one that is accessible from multiple spots but is not in a high traffic area*.)
Be sure to check the locks (*that they are coded to the clues and securely fastened to the box*es).
Either place a prize in each box OR a Sign that says, "WE BROKE OUT!" with instructions to add a team picture with the sign, to a social media page.

Solutions to Breakout Codes:

- GCF of 90 and 108: prime factorization is 3 x 3 x 2 = 18, sum of digits = 9 (Nine) - alpha lock code is "N"
- GCF of 165 and 275: prime factorization is 5 x 11 = 55, sum of digits = 10 (Ten) - alpha lock code is "T"
- GCF of 90 and 60: prime factorization is 3 x 5 x 2 = 30, sum of digits = 3 (Three) - alpha lock code is "T"

- GCF of 62 and 124: prime factorization is 2 x 31 = 62, sum of digits = 8 (Eight) - alpha lock code is "E"

Adaptations:

- Use one box at the front of the room and have teams send one individual to try the lock (*saves materials/money and set-up time*).
- Use different combinations on locks (*this would require 4 new sets of codes – GCF clues)*
- The first clue is given, each box opened gives a clue to the next box to unlock (*More advanced breakout – for students with prior breakout experiences*)

Engage

Provide students with the following scenario (or one similar):

> "After spending years in search of the elusive Great Factorial Treasure, risking life and limb to discover its location, digging through layers of dirt and rock and ancient artifacts, you have found it! All that separates you from claiming this great discovery is a single lock. Now, you must rely on your vast mathematical knowledge to solve the final steps of the mystery. What truly lies within?"

Explore

Students will find the GCF for 4 pairs of numbers using factor trees (see resources for more information). The sum of the digits in each GCF is a clue to the letters in the combination lock. (Ex. GCF of 90 and 108 is 18. 1 + 8 = 9 [Nine], so the first letter in the combination is an N.) Do not tell the students that it's the first letter of the number's name. See attached sheet for all sets of questions.

Explain

Students move out of groups and back to seats. Ask volunteers to give 3 of each of the following: What made this challenging? What ideas did you consider for changing a number to a letter? What helped you solve it?

Elaborate

Students create their own clues using GCFs with a matching letter and explain how they are connected.

Evaluate

Give students one more pair of numbers and ask them to find the GCF using factor trees.

Assessment Notes:

Pair students who could not find the GCF independently with a buddy (*someone who also couldn't find it OR someone who struggled a while to find it*).

Teacher Biographical Information

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Resources

Clue Sheets *(attached*)
Using Factor Trees to find the GCF (*attached*)
For Lock Box Materials – Target, Walmart, Amazon, 'Dollar' stores or Breakout.edu
For Free Breakouts: https://www.breakoutedu.com/freegames

1. Find the GCF of 90 and 108. Add the digits. First letter: ________________ 2. Find the GCF of 165 and 275 Add the digits Second letter: _____________ 3. Find the GCF of 90 and 60. Add the digits Third letter: _____________ 4. Find the GCF of 62 and 124. Add the digits. Fourth letter: _____________	1. Find the GCF of 90 and 108. Add the digits. First letter: ________________ 2. Find the GCF of 165 and 275 Add the digits Second letter: _____________ 3. Find the GCF of 90 and 60. Add the digits Third letter: _____________ 4. Find the GCF of 62 and 124. Add the digits. Fourth letter: _____________
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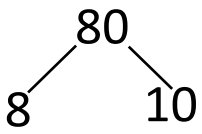
Factor Trees

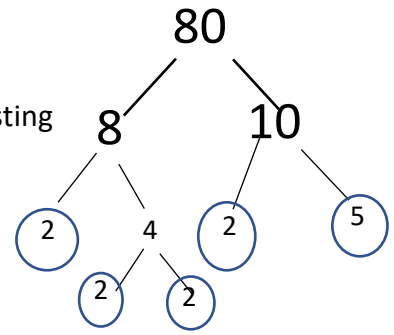
A **factor tree** breaks down a number into its prime components. To create a factor tree, write the starting number (*product)*. Underneath the product number write any factor pair that equals the product. For example; 8 and 10 are written under the branches of 80, because the factors, 8 and 10, when multiplied, equal 80. (8 x 10 = 80)



Next, repeat the process with new branches under each factor (*in this example, 8 and 10*). When a **prime number** (*a number whose factors are 1 and itself*) emerges in a factor pair, circle it.

The tree is completed when all branches end with prime numbers (*circled numbers*). To summarize the results, create a **prime factorization** sentence listing the primes from least to greatest. If you have multiples of a prime number, group them together in order.

2 x 2 x 2 x 2 x 5



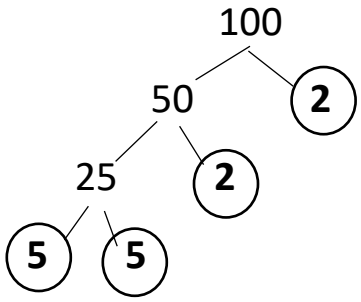
Finding the Greatest Common Factor using Factor Trees

To find the GCF of two or more numbers, factor each number using a factor tree and find the prime factorization of each number.

For example, find the GCF of 80 and 100.

The prime factorization for 80 is shown above = 2 x 2 x 2 x 2 x 5.

The prime factorization of 100 is 2 x 2 x 5 x 5. One factor tree that could be used to find this is:



Look at the circled prime numbers is each number, 80 and 100. Find the prime factors they have in common. In this case, they share two 2's and one 5. So, the GCF is 2 x 2 x 5 = 20.