NUMB3RS Activity: The Missing City
Episode: "Spree, Part I"

Topic: Logical Reasoning   **Grade Level:** 9 - 10
Objective: To use logical reasoning to analyze data and make a conjecture.
**Time:** 20 - 30 minutes
Materials: Internet access and/or a map of western half of the US (or several maps of states in that region)

Introduction

In "Spree, Part I," Don and Edgerton (another agent) have plotted a precise map of a crime spree carried out by two lovers. The map ranges from Austin, TX, to San Bernardino, CA, through the cities given below. Charlie thinks the criminals visited another city along the way but did not commit a crime there. In this activity, students are asked to compute the mileage between the pairs of cities along the route and make a conjecture about the location of the "missing city" that Charlie thinks the criminals visited.

The cities in the spree (in order) are: Austin, TX → Mesquite, TX [Dallas County] → Oklahoma City, OK → McPherson, KS → Colby, KS → Ft. Collins, CO → Salt Lake City, UT → Milford, UT → Las Vegas, NV → San Bernardino, CA.

In this activity, the student is asked to "solve a mystery" by gathering and analyzing data to make a conjecture. Unlike usual *NUMB3RS* activities, there are no sophisticated mathematical tools needed – only basic arithmetic is required.
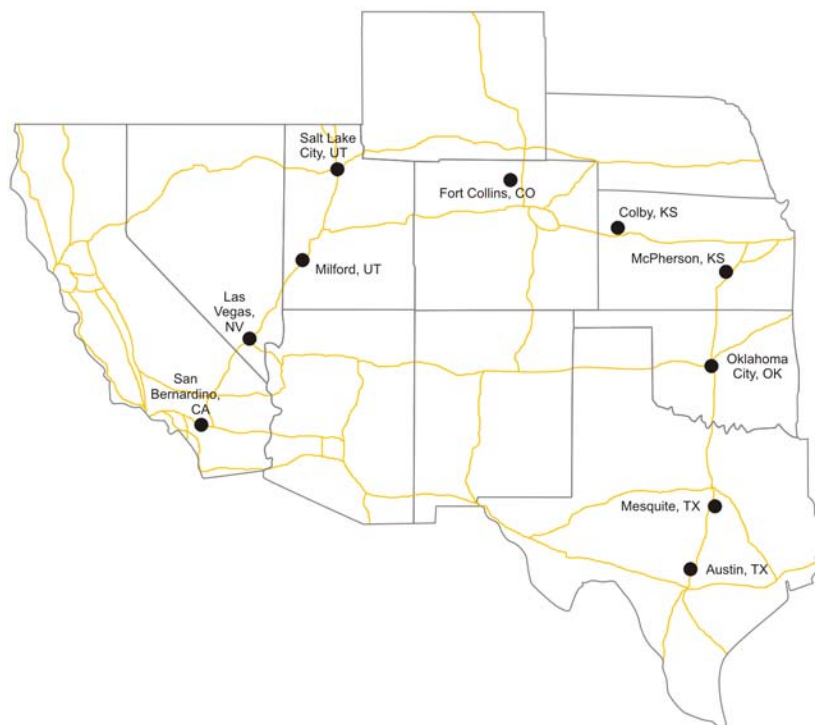
Discuss with Students

Be sure students know how to access a Web site such as **www.randmcnally.com** or **www.mapquest.com**. In this activity, it is assumed that the criminals travel by car and take the fastest route – typically the one using interstate highways. To find the distance between two cities, simply enter the names of the cities and click "Get Directions."

If Internet access is unavailable, be sure the students can read a map and find the distance between two cities along highways. In the Extensions, it is assumed that the criminals use a small airplane. Be sure that students can compute the "air distance" between two cities; this can be done by finding the length of the segment joining them on the map and then using the scale from the legend of the map.

Student Page Answers:

1. Approximate distances between cities are given in the table below.

| City [Start]	City [End]	Mileage
Austin, TX	Mesquite, TX	205
Mesquite, TX	Oklahoma City, OK	216
Oklahoma City, OK	McPherson, KS	216
McPherson, KS	Colby, KS	237
Colby, KS	Fort Collins, CO	287
Fort Collins, CO	Salt Lake City, UT	477
Salt Lake City, UT	Milford, UT	229
Milford, UT	Las Vegas, NV	224
Las Vegas, NV	San Bernardino, CA	226

2. The distance between Fort Collins, CO, and Salt Lake City, UT, is much greater than the distance between the other cities. The "missing city" was most likely on the route between these cities, which crosses through southern Wyoming. Reasonable choices for the missing city are Rock Springs, WY, Green River, WY, and possibly Rawlins, WY. Charlie chose Green River.

Name: _____ Date: _____

NUMB3RS Activity: The Missing City

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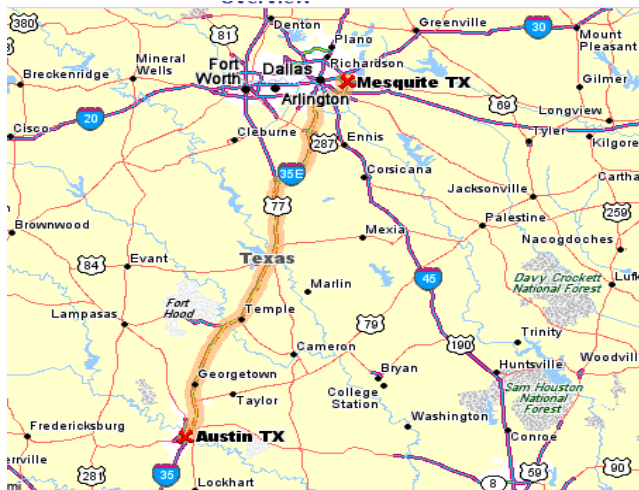
The cities in the spree (in order) are: Austin, TX $\rightarrow$ Mesquite, TX [Dallas County] $\rightarrow$ Oklahoma City, OK $\rightarrow$ McPherson, KS $\rightarrow$ Colby, KS $\rightarrow$ Ft. Collins, CO $\rightarrow$ Salt Lake City, UT $\rightarrow$ Milford, UT $\rightarrow$ Las Vegas, NV $\rightarrow$ San Bernardino, CA
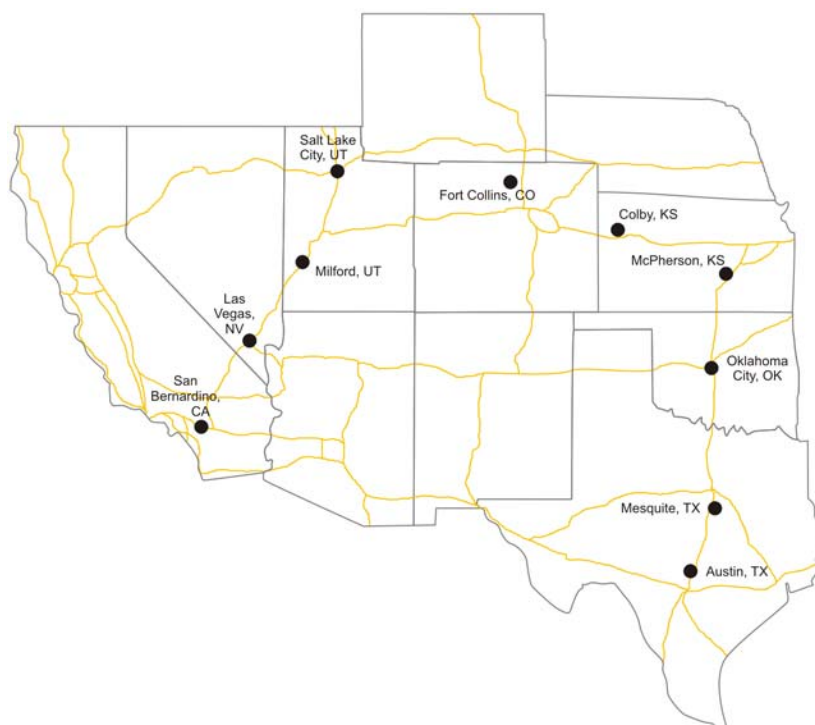
1. Assume the criminals traveled by car and took the fastest route between any pair of cities – usually on interstate highways. You can use Web sites such as **www.randmcnally.com** or **www.mapquest.com** to find the driving distance between each pair of adjacent cities in the crime spree. The map on the next page shows a sample result for finding the driving distance from Austin, TX, to Mesquite, TX.

[Source: **www.randmcnally.com**]

Austin to Mesquite: 205 miles

Now find the distance between each pair of adjacent cities in the crime spree, and record your findings in the table below.

City [Start]	City [End]	Mileage
Austin, TX	Mesquite, TX	205
Mesquite, TX	Oklahoma City, OK	
Oklahoma City, OK	McPherson, KS	
McPherson, KS	Colby, KS	
Colby, KS	Fort Collins, CO	
Fort Collins, CO	Salt Lake City, UT	
Salt Lake City, UT	Milford, UT	
Milford, UT	Las Vegas, NV	
Las Vegas, NV	San Bernardino, CA	

2. Examine the data in the table and look at the maps of the suggested routes. Make a conjecture about the location of the "missing city" – the city where Charlie thinks the criminals visited but did not commit a crime. Explain why you think your conjecture is correct.

The goal of this activity is to give your students a short and simple snapshot into a very extensive math topic. TI and NCTM encourage you and your students to learn more about this topic using the extensions provided below and through your own independent research.

Extensions

For the Student

Suppose the criminals had a small private airplane instead of a car. Recalculate the data in the table from Question 1 by finding the approximate air distance between each pair of cities. To find this distance, use a map and a ruler to measure the length of the segment between the two cities. Then use the scale from the legend of the map and proportional reasoning to estimate the air distance. Make another conjecture about the "missing city." Did you choose the same city that you chose in Question 1?

Related Topics

- Plan a week-long road trip, beginning and ending at your home, where you visit six other cities, under the condition that you can use only one tank of gas to go from one city to the next. Prepare an itinerary for your trip.

- If you enjoy using and making maps, you might look at the types of maps and the Map Maker tool to customize a map at **www.nationalatlas.gov** or **www.nationalgeographic.com/xpeditions/atlas**.

- Many people often take business trips visiting several cities. Suppose that a person in Dallas needs to visit Boston, LA, and Seattle. The travel expenses between each pair of cities (in dollars) are given in the table below.

	Boston	**LA**	**Seattle**	**Dallas**
Boston	--	458	651	317
LA	458	--	184	229
Seattle	651	184	--	392
Dallas	317	229	392	--

- **a.** If the person needs to start and end in Dallas, in what order should the person visit these three cities to minimize her travel expenses? Give reasons for your answer.

- **b.** Suppose the person was transferred to Seattle. If she made a similar trip to Boston, LA, and Dallas (starting and ending in Seattle), will her minimum travel expenses be different from the amount for the trip in part a? Give reasons for your answer.

- **c.** This problem is an example of the "Traveling Salesman Problem." It is an unsolved problem that you may wish to investigate further on the Internet.