**Biking through the Mountains**

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| In this lesson, students will represent and solve two-step word problems involving addition and multiplication with whole numbers. Students will distinguish multiplicative comparison from additive comparison when solving a problem about biking. |

**NC Mathematics Standard:**

**Operations and Algebraic Thinking**

**NC.4.OA.3** Use the four operations with whole numbers to solve problems:

* Solve two-step word problems involving the four operations with whole numbers.
* Use estimation strategies to assess reasonableness of answers
* Represent problems using equations with a letter standing for an unknown quantity.

**NC.4.OA.1** Interpret a multiplication equation as a comparison. Multiply or divide to solve word problems involving multiplicative comparisons using models and equations with a symbol for the unknown number. Distinguish multiplicative comparison from additive comparison.

**Standards for Mathematical Practice:**

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

2.  Reason abstractly and quantitatively.

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

4.  Model with mathematics.

7.  Look for and make use of structure.

8.  Look for and express regularity in repeated reasoning.

**Student Outcomes:**

* I can use estimation strategies to assess reasonableness of answers.
* I can represent problems using equations with a letter standing for an unknown quantity.
* I can use the four operations to solve problems.

**Math Language:**

* additive comparison
* multiplicative comparison
* product
* equation
* reasonableness

**Materials:**

* pencil
* grid paper
* handout (optional)

**Advance Preparation**:

* Display problem on board or print handout so students have a copy of the problem. You may want students to glue the problem in their math journals or work papers.

**Launch:**

1. Introduce Problem (5 – 10 minutes)

Ask students if they have ever gone biking.  Some possible questions to encourage engagement: What do you like about biking? What kind of bicycle do you have? Where do you like to bike? Have you ever been on a bike trail or long bike ride?

Display some of the biking routes through North Carolina (<https://www.ncdot.gov/bikeped/ncbikeways/>). Point out the Southern Highlands route (<https://www.ncdot.gov/bikeped/ncbikeways/routes/nc8-southern-highlands/>). This 120 mile route begins northwest of Brevard and passes through several small mountain towns including Brevard, Saluda, Flat Rock, and Tryon. It traverses the foothills of the Blue Ridge Mountains. Point out some of these locations on a map of North Carolina.

Have students describe what they might bring on a bicycle trek through the mountains.

Present the following problem to students:

You and your friends begin a 120 mile bike route through the Blue Ridge Mountains of North Carolina. On the first day, you and your friends bike 5 miles.  The second day you bike 4 times as far as you did the first day, and the third day you bike 6 miles less than the second day.  How many miles did you bike altogether?

**Explore:**

1. Solving the Problem (15 – 20 minutes)

Allow students time to work individually and then with partners in order to solve the task.  As students work, observe students to see how they are solving the task. Encourage students to share their strategies with one another and describe how they are answering each question.

Observe:

* How are students understanding the problem?
* How are students organizing and representing their thinking?
* How do students interpret the numbers that say 4 times as far as the first day and 6 miles less than the second day?
* What vocabulary are students using as they solve the task?

Carefully select students to present to the class.  Look for students who modeled the problem. Also look for strategies that will generate discussion to help others move toward a deeper understanding of problem solving.

**Discuss:**

1. Discussion of Solutions (15 – 25 minutes)

Bring the group back together and have selected students share their strategies for solving the task.  Relate the task an additive comparison or multiplicative comparison.

Possible points to address and questions to ask:

* Discuss and relate various modeling strategies (tape diagrams, charts or tables, etc.)
* If you understand 4 times as far, how can you express this as an equation?
* If you understand 6 miles less than the second day, is order in the problem of importance?
* Discuss the difference between additive and multiplicative comparison. Why did you multiply in this part of the problem? Why did you subtract in this part?

**Evaluation of Student Understanding:**

**Informal Evaluation:**

* Observe and monitor students as they solve the problem.  How are they making sense of the problem? Are they using a tape diagram, additive comparison or a multiplicative comparison equation?Can students explain why their answer is reasonable?

**Formal Evaluation/Exit Ticket:**

* At the end of the lesson, ask the students to write an equation to describe each statement:

My family traveled in a car for a three day trip to Florida. On the first day we drove 250 miles. On the second day we drove twice as far as the first day. Finally, on the third day, we drove 300 miles less than on the second day.  How many miles did we travel for all three days? Explain why your answer is reasonable.

**Meeting the Needs of the Range of Learners:**

**Interventions:**

* Students may want to highlight each part of the problem and decide what to do in that part of the problem. Does order matter in solving the problem? Have students explain why.
* Suggest that students use models such as tape diagrams on grid paper to help them solve the task and visualize patterns.

**Extensions:**

* Ask students to create a representation to show the number of miles traveled if the same pattern continues for 6 days (add 5, multiply by 4, subtract 6). (Day 6 = 170 miles)
* Have students determine how many miles are left to travel to complete the 120 mile route (120 – 39 = 81 miles).

**Possible Misconceptions/Suggestions:**

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| **Possible Misconceptions** | **Suggestions** |
| * Students do not understand the wording of the problem. * Students do not realize which operation to use. * Students do not understand that order matters in solving the problem. | * As a class, act out the problem with smaller numbers. * Discuss as a class, asking questions to encourage students to estimate numbers. |

**Special Notes:**

* This lesson addresses standard NC.4.OA.3 (problem solving) as well as NC.4.OA.1 (multiplicative comparison). This lesson should be embedded with other lessons that address NC.4.OA.1.

**Possible Solutions:**

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| **Task:**  5 + (5 x 4) + (5 x 4 – 6) = N  N = 39 miles  Other possible solutions:  Day 1: 5 miles  Day 2: 20 miles  Days 3: 20 - 6 = 14  Total miles bikes: 5 + 20 + 14 = N  N = 39 miles | **Exit Ticket:**  250 + (250 x 2) + (250 x 2 – 300) = N  N = 950 miles  Other possible solutions:  Day 1: 250  Day 2: 500  Day 3: 500 - 300 = 200  250 + 500 = 750;  200 + 750 = 950 total miles traveled  N= 950 |

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