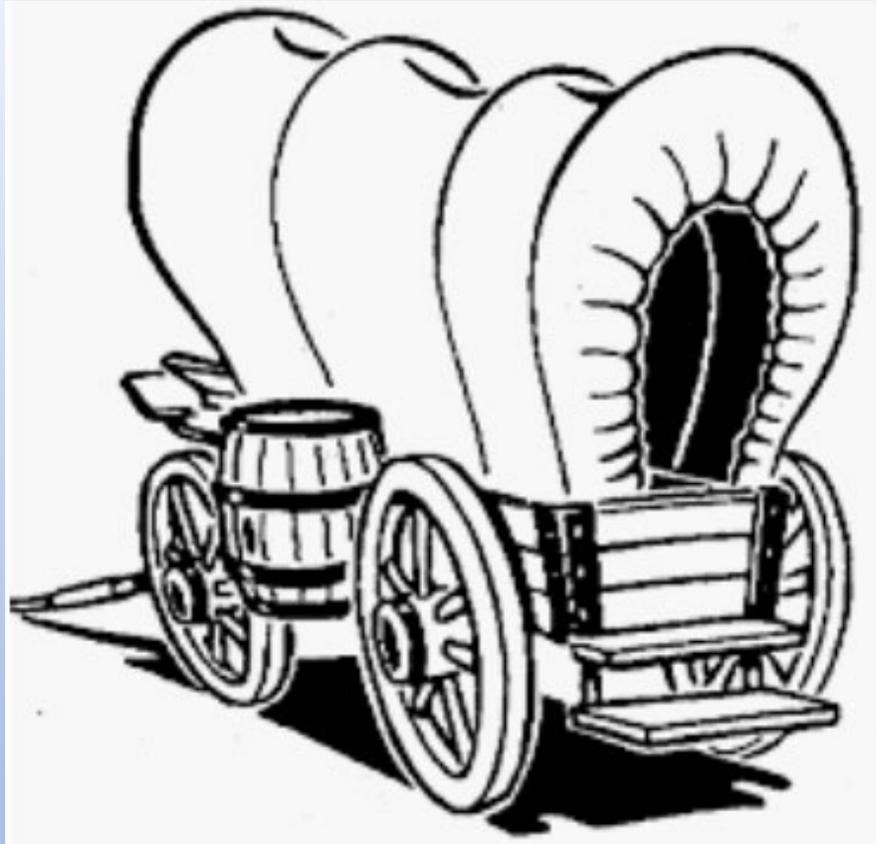


**WEST VIRGINIA
DEPARTMENT OF EDUCATION**



MATHEMATICS

GRADE 7

Wagon Trails

Table of Contents

| | |
|---|---------------------|
| Rationale for Lesson and Associated Tasks | Page 1 |
| Lesson and Associated Tasks Overview | Pages 1 - 2 |
| West Virginia College-and Career-Readiness Standards | Page 3 |
| Mathematical Habits of Mind (MHM) | Page 3 |
| Mathematics Teaching Practices to Support Student Growth | Page 3 |
| Essential Understandings | Page 3 |
| Set-up Phase | Page 3 |
| Establish Small Groups | Page 4 |
| Develop Open-Ended Questions | Pages 4 - 5 |
| Gather Materials | Page 5 |
| Anticipated Common Student Misconceptions | Page 5 |
| Prior Instruction/Knowledge | Pages 5 - 6 |
| Implementation Phase | Pages 6 - 9 |
| Share, Discuss and Analyze Phase | Pages 9 – 10 |
| Task in Action | Page 10 |



Task Title: Wagon Trails Pioneer’s Journey

Grade or Content Area: 7th Grade

Toolkit Author: Sheila Ruddle, Nada Waddell, and Shannon Henderson

Original Task Creator: MidSchoolMath

Quarter: 1

Rationale for Lesson and Associated Tasks

A wagon train is traveling from Santa Fe to Ciudad de Mexico (Mexico City). By providing students with a map and a wagon guide, pioneers must prepare for their journey by selecting a trail and by buying food. Will they have enough food and water to survive the trip and reach their destination?

The Wagon Trail Pioneer’s Journey task provides students with the opportunity to apply and extend knowledge on ratios, rates, unit rates, and proportions in a real-life scenario. This task requires students to gather, analyze, organize, and apply information to successfully complete a journey in the frontier Old West. There are several factors in the problem that require students to consider the effect that changing one quantity may have on the outcome of another variable.

Lesson and Associated Tasks Overview

The Pioneer’s Journey* ([click here](#))

The Pioneer’s Journey Lesson Plan* ([click here](#))

**Review all components thoroughly.*

The task is set up through an interactive simulation. The link above provides the teacher with access to the simulation, all materials needed to print and prepare for students, and the student portal for the simulation.

The task consists of a video to introduce and set the scene of the task. Provided materials include a map, a wagon guide, and instructions for the teacher and the students. Students are tasked with choosing a safe route for the journey and completing a purchase order for the necessary food items based on their knowledge of ratios and proportions and the information provided in the wagon guide. When students have determined their route and the necessary amounts of provisions, they submit a purchase order through the portal. After all student teams have entered purchase orders, the journey begins. Students watch the wagons begin the journey and the simulation showing when and why a wagon does not successfully complete the journey. A follow-up video is provided in which the team of actors shares one possible reasoning pathway.

This lesson and associated tasks are scheduled to be completed over 3 class periods per the suggested sequence:

Please note:

Allow for part of a class period prior to **Day 1** to assign “Teams”. Describe the situation briefly as a problem having to do with the pioneer days in the Old West. Have teams meet to select a Team Name, to make a Team Sign, and to take a Team Selfie or to select a computer image to be associated with their team. At this time, teams can also make a Traveler’s Log, which is basically scratch paper in booklet form, with a decorated cover on it. In regard to the Team Selfie, there may be some concern about Internet safety. It is the belief of this author that the selfie never actually “leaves the classroom.” As evidence, each time the team enters a new route and new food amounts, the Team Name and Team

Selfie have to be re-entered; it doesn't seem to be saved to the site. However, if there is concern, other options are given. A team can make a sign and take a picture of that, or an image can be found on the Internet, downloaded, and used for a Team Picture.

Day 1

- Introduce the *Pioneer's Journey* task to students. (whole class)
- View *Pioneer's Journey Immersion* video with students. (whole class)
- Present students with Zeb Hardy's Surefire Instructions and have them select a wagon team and enter their Team Name and Team Selfie. (See earlier note about preparing for this and about Internet safety concerns.)
The code should have appeared after watching the video.
- Provide students with their *Traveler's Log*, *Printable Map*, *Zebulon Hardy's Wagon Guide*, and a *Purchase Order*.
- Guide teams of students as they study the map and wagon guide to determine a route and quantities of food. (small groups)
- Have students enter their information into the portal.
- Run the simulation to see if teams reach the destination safely. If teams did not, they should note the reason.
- **Caution!!! If at least one team is successful in reaching Mexico City, there is a video that explains one solution. It is rather step-by-step. Do not show this video until students have had other chances to complete the trip and until you have processed the task with the class.**
- Optional – begin compiling a class chart of "Trail Traveled", "Amount of Beans, Bacon, Flour, Rice, Butter", "Safe Passage?", "If not, Reason".

Day 2

- Provide teams time to review the work they did on Day 1. If they were not successful in reaching Mexico City, they should re-think and revise their plan. If they were successful, they should try to find another solution to successfully reach the destination. (small groups)
- Run the simulation again, as on Day 1, but with the new selections.
- Have teams record their choices and their results in their Travelers' Log and on the class chart.
- **Caution!!! If at least one team is successful in reaching Mexico City, there is a video that explains one solution. It is rather step-by-step. Do not show this video until students have had other chances to complete the trip and until you have processed the task with the class.**

Day 3

- Process the task with students, taking each of the components (choice of trail, number of days, total amount of food, amount of each food) of the trip and focusing on how they used mathematics to make their selections
- Allow teams one more attempt at the simulation.
- Run the simulation.
- Watch the video clip of a solution.

West Virginia College- and Career-Readiness State Standard

The Standard addressed in this lesson comes from the Ratio and Proportional Relationship cluster which states, “Analyze proportional relationships and use them to solve real-world and mathematical problems.”

M.7.3

Use proportional relationships to solve multistep ratio and percent problems (e.g., simple interest, tax, markups and markdowns, gratuities and commissions, fees, percent increase, and decrease, and/or percent error).

Students will use proportional reasoning:

- to select a trail, based on previous success rates and the amount of available water.
- to find the distance of the trails, based on a map scale.
- to find the number of days for the trip, based on a distance traveled per day rate.
- to find the total amount of food needed, based on a pounds per day rate.
- to find the amount of each food needed based on proportions given.

Mathematical Habits of Mind (MHM)

*While several MHM are listed, the MHM in bold font is the focus of the lesson and associated tasks.

MHM1. Make sense of problems and persevere in solving them.

MHM2. Reason abstractly and quantitatively.

MHM3. Construct viable arguments and critique the reasoning of others.

Mathematics Teaching Practices to Support Student Growth

- Implement tasks that promote reasoning and problem solving.
- Facilitate meaningful mathematical discourse.
- Support productive struggle in learning mathematics.
- Pose purposeful questions.

Essential Understandings

- An understanding of proportions/proportional reasoning is an effective tool in addressing many real-world situations.
- Proportional relationships exist between two variables that vary directly with each other when two variables have a constant ratio between them.

Set-up Phase

1. Become an Expert in the Task

It is essential that you, the teacher, become very familiar with all *Wagon Trail Pioneer's Journey* materials (e.g. Lesson Plan, Student Instructions, portal, videos, and student handouts). Working through the task as the teacher and as a student, prior to using this with students, is imperative to the success of this lesson. By doing this, the teacher will understand how the simulation works, and will find what information the students are looking for and what concepts are being accessed and assessed in this task. This also provides an opportunity to explore and anticipate the multiple solution pathways that students may choose.

2. Establish Small Groups (Teams)

The Wagon Trail Pioneer's Journey task promotes both individual and small group thinking. Students bring their individual thinking to a meaningful discussion as they work collaboratively to solve a real-life problem that involves ratio and proportion.

Skill levels, leadership skills, and personalities are all considered when creating small (e.g. three students) groups. Small group collaboration works best when students have been provided previous opportunities to work together on a regular basis. Weeks of teacher observation of student behavior will be extremely helpful when creating small groups for this lesson and associated tasks. Taking notes regarding leadership skills, personalities, the ability to take criticism, to question, and to think deeply about a task or problem will enable teachers to make sound decisions regarding small group placement. When creating the groups, all these factors help to eliminate the potential situation in which one student takes the lead and makes the decisions for the group. In this scenario, one student is gaining all the benefits of the task, while others do not. If a student is not engaged in conversation, this lesson and associated tasks will not be beneficial in helping all students to have meaningful discussions about the mathematics involved nor in analyzing the relationships inherent to the tasks. Students will be working together when placed in small (e.g. three students) to complete this task. The goal is for all students to participate in discussion and decision-making.

3. Develop Open-Ended Questions

Teachers should create a list of open-ended questions designed to support and scaffold the task for struggling students. These questions should purposefully direct students towards necessary decisions and/or provided information, previously learned content, and similarities and differences in their work versus that of group members. Some questions might include:

Questions appropriate for Day 1 --

- What information is needed to start the task?
- What information can be found in the wagon guide booklet? How can you use this information?
- How can you determine which route to take?
- What information does the map provide? How can you use this information?
- What information can help you decide which route to take?
- What information can help you determine how long the journey will take?
- How can you determine how long (distance and/or time) the journey is?
- What materials or tools can you use to help you to determine how long the journey is?
- How can you determine how much food is needed?
- How can you determine how much of each type of food is needed?
- How does (the route, the total amount of food needed, etc.) affect the (amount of water needed, the total amount of food needed, the amount of each food needed, etc.)?

Questions that are more specific to the needed mathematics and are more appropriate for Day 2 –

- Why wasn't your journey successful?
- What can you adjust to make your journey successful?
- Can you find another solution that will allow you to have a successful journey?
- How do you use the map scale?
- If you know the distance traveled, what do you do to find the number of days the trip will take?
- What do you do if you know the total distance and how far you can travel in one day?

- If you know the number of days the trip will take, how can you find how much food is needed?
- What do you do if you know the number of days and how much food you need in one day?
- What does it mean when it says that your food wasn't proportioned correctly?
- What is meant by "2 parts", etc.?
- If you know how much food is needed, how do you find 2 parts, etc.?

4. Gather Materials

- Computer and Presentation Device (required for teacher usage and possible student usage) (Teams may each have a computer, if available.)
- Internet access (Test the portal prior to implementation with students and allow time to have it loaded each time it is used.)
- Student computers (one per team, optional)
- Calculators (optional)
- Traveler' Log (one per team)
- Scratch paper
- String/Rulers (optional)
- Markers (optional)
- Chart paper (optional)
- Handouts -- at least one of each per team. These must be copied and assembled prior to beginning the lesson! (Task-provided map, Task-provided wagon guide booklet, Task-provided student instruction – [click here](#))
- Portal (Online): Wagon Trails Pioneer's Journey -- [click here](#) (Test the portal prior to implementation with students.)

5. Anticipated Common Student Misconceptions

- Students may not value the information in the field guide, and that there are mathematical processes that can give them a better chance at reaching the destination.
- Students may assume that there is a "50/50 chance" of reaching the destination. They will either survive or they won't.
- Students may not have an understanding of how to use the map scale to calculate the distance, and therefore the number of days to complete the trip.
- Students may not understand the idea of "perfect proportion" of the various food choices, and the importance of this in reaching the destination.

Prior Instruction/Knowledge:

In Grade 6, ratios, rate, and percentage are connected to whole-number multiplication and division and the concepts of ratio and rate are used to solve problems. In Grade 7, students continue this study by developing an understanding and application of proportional relationships, including percentages.

This task is not a skill-specific task; it incorporates the use of many of the skills related to ratio and proportion. As such, it may best serve as a thought-provoking and engaging introduction to a unit on proportional reasoning. It can serve to prompt students' prior knowledge regarding ratio and rate and reveal student misconceptions. It could also be used as a follow-up to this unit of study, to find if students can apply what they have learned to this non-routine situation.

Please review the following:

Educators Guide for Mathematics: Grade 6 (pages 4-17, pdf pages 6-19) ([click here](#))

Educators Guide for Mathematics: Grade 7 (pages 4-14, pdf pages 6-16) ([click here](#))

Prerequisite Skills

- Write a ratio or rate to compare two quantities.
- Given a proportional relationship represented by tables, graphs, models, or algebraic or verbal descriptions, identify the unit rate (constant of proportionality).

Supporting Skills

- Make predictions based on results from surveys and samples.
- Calculate unit rates in number and word problems, including a comparison of unit rates.
- Determine the probability from experimental results or compare theoretical probabilities and experimental results.
- Solve number and word problems using percent proportion, percent equation, or ratios.
- Relate a percent to its equivalent fraction or decimal.
- Write a proportion to model a word problem; solve proportions.
- Write a linear equation or inequality to represent a given number or word problem; solve.
- Model the concept of percent and relate to the value in decimal or fractional form.

Impending Skills

- Write equations to represent direct variation and use direct variation to solve number and word problems.
- Determine and use scale factors to reduce and enlarge drawings on grids to produce dilations.
- Use proportional reasoning to solve problems related to similar polygons.
- Calculate or estimate the percent of a number including discounts, taxes, commissions, and simple interest.

Source: *The Quantile Framework for Mathematics*

<https://metametricsinc.com/educators/quantile-for-educators/>

2020 MetaMetrics Inc.

Implementation Phase

Day 1

- Introduce the *Pioneer’s Journey* task to students. (whole class)
- View *Pioneer’s Journey Immersion* video with students. (whole class)
- Present students with Zeb Hardy’s Surefire Instructions and have them select a wagon team and enter their Team Name and Team Selfie. (See earlier note about preparing for this and about Internet safety concerns.) The code should have appeared after watching the video.
- Provide students with their *Traveler’s Log*, *Printable Map*, *Zebulon Hardy’s Wagon Guide*, and a *Purchase Order*.
- Guide teams of students as they study the map and wagon guide to determine a route and quantities of food. (small groups)
- Have students enter their information into the portal.
- Run the simulation to see if teams reach the destination safely. If teams did not, they should note the reason.

- **Caution!!! If at least one team is successful in reaching Mexico City, there is a video that explains one solution. It is rather step-by-step. Do not show this video until students have had other chances to complete the trip and until you have processed the task with the class.**
- Optional – begin compiling a class chart of “Trail Traveled”, “Amount of Beans, Bacon, Flour, Rice, Butter”, “Safe Passage?”, “If not, Reason”.

Day 1 Teacher Notes:

Day 1 is a day of exploration in which students become familiar with the problem that is presented to them and with the provided materials.

1. As a teacher, the temptation might be to guide the students through the process. As tempting as this may be, it is important for students to wrestle with the materials. This productive struggle is important to their learning. From the teacher’s point of view, the struggle may not seem productive, but it will eventually prove to be beneficial. It also might be tempting to give students a graphic organizer to guide them through the process. By doing this, the built-in opportunity to “make sense of problems and persevere in solving them” will be taken away from the students. However, it is important for students to keep a record of their thinking and their steps to arrive at their solution. Having them keep a Travelers’ Log will be important to them, as it will require them to keep a record of decisions that they make, and it will provide evidence of what they did to make those decisions. This will help them revise their solution and explain their solution as the class processes the task.
2. As class begins, students should be seated in teams. Briefly describe the situation, that is, their task is to “travel” by wagon train from Santa Fe to Mexico City. Materials will be provided to help them prepare for their trip so they can arrive safely.
3. Show the immersion video. After the video is watched, a code will appear that students need in order to enter their purchases.
4. Provide students with their Travelers’ Log, instructions, a map, a wagon guide, and a purchase order. Have string, rulers, markers, and additional scratch paper available if they ask for these materials.
5. Allow students time to grapple with the problem. Instruct them that they will be making several decisions. Each time they make a decision, it is important that they record evidence in their Travelers’ Log.
6. Be available by walking around the room (students tend to ask questions if the teacher is nearby), but don’t interfere with group discussions, unless asked. Refer to the list of questions given previously in this document. Some teams may need some gentle nudging if they seem to not have any idea of how to begin. Other teams may ask questions. Clarify without “telling”, and answer with another question.
7. In order to later process the task, it may be important for the teacher to keep a record of conversations that are heard so that they can be highlighted.
8. Do not expect that all (or any) teams will pick up on all the important information in the first trial. You may actually anticipate some guessing. Do not lead teams to finding the information.
9. Teachers should plan for teams who quickly complete their purchase orders. Such students could be asked to explain their reasoning process, to re-check the accuracy of computations, to revisit the task-provided information to verify that all was addressed.
10. Logistics will vary depending on the situation. If student computers are available, students can log into the student materials at any time. If only one classroom computer is available, the teacher will have to manage and monitor computer usage.

11. As teams find their solutions, they should enter them into the portal. When all teams have entered solutions, run the simulation. It is important that each team keep a record of each of their simulations in their Traveler's Log. They should record the trail traveled, the amount of each food, whether or not they had a safe passage, and if not, the reason for their demise.

Caution!!! If at least one team is successful in reaching Mexico City, there is a video that explains one solution. It is rather step-by-step. Do not show this video until students have had other chances to complete the trip and until you have processed the task with the class.

Optional -- Begin compiling a Class Data chart, however, do not allow teams to see others' selections.

Day 2

- Provide teams time to review the work they did on Day 1. If they were not successful in reaching Mexico City, they should re-think and revise their plan. If they were successful, they should try to find another solution to successfully reaching the destination. (small groups)
- Run the simulation again, as on Day 1, but with the new selections.
- Have teams record their choices and their results in their Travelers' Log and on the class chart.
- **Caution!!! If at least one team is successful in reaching Mexico City, there is a video that explains one solution. It is rather step-by-step. Do not show this video until students have had other chances to complete the trip and until you have processed the task with the class.**

Day 2 Teacher Notes:

Day 2 offers teams a second chance at completing the journey successfully. Upon entering the teacher portal, you will find the immersion video. It is important to note that it is not necessary to run this video again on Day 2. The video can be 'X'ed, the student code will be given, and the simulation can be run. For teams that did not survive on Day 1, encourage them to adjust their selections based on the reason for their failure. Part of the teacher's role might be to guide students to the part of the Wagon Guide that addresses why they failed. For teams that were successful, remind them to review what they did on Day 1, looking particularly at the mathematics they used. Have them see if they can find a second successful solution. Anticipate that students might have more specific questions on Day 2, as they key in on important information. Review the questions that were provided earlier in this document to be prepared to answer students' questions without giving them specific procedures.

Day 3

- Process the task with students, taking each of the components (choice of trail, number of days, total amount of food, amount of each food) of the trip and focusing on how they used mathematics to make their selections.
- Allow teams one more attempt at the simulation.
- Run the simulation.
- Watch the video clip of a solution.

Day 3 Teacher Notes:

The timing of "Day 3" is important. If this is an introductory task, the teacher may choose to move to the unit of study, revisiting this at the end. If this is used as a wrap-up of a unit, the teacher will want to do

Day 3 immediately after Day 2. Even in the wrap-up of the task, the teacher should assume the role of asking questions rather than directly teaching. Students should be asked to explain how they made decisions (focusing on the mathematics). A variety of methods might be shown, and this should be encouraged. The teacher's notes become essential in making sure that important conversations are highlighted. Use the class chart of records. Focus on trips that did not result in a safe passage. Use examples of food selections to find the proportions of food and compare them to the "perfect proportions" that were given. Give teams a chance to try the simulation one more time. Compare successful solutions in the class to the one on the video clip.

Share, Discuss, and Analyze Phase

Essential Understanding #1:

An understanding of proportions/proportional reasoning is an effective tool in addressing many real-world situations.

Share- The lesson opens with students being presented a video and a problem, to find the route and correct amount of provisions that will give them safe passage to their destination. Upon the conclusion of the video, student teams will work together to find a successful solution.

Discuss- Student teams work together and should discuss the following: What are the proportional relationships in this problem? How can proportional reasoning help us find solutions that will give us safe passage? As noted in teacher notes in other parts of this document, on the first and possibly even the second attempt, students may not focus on all the proportional relationships that can help them find a solution. By asking the guiding questions that are noted above, the teacher can lead students to understanding in some of the elements.

Analyze – Through discussion, students should be led to the conclusion that the following are proportional relationships and can be used in solving the problem:

- We can find the best trail by using the success rate of previous trips, as shown in River Crossings.
- We can find the distance of the route by using the map scale.
- We can find the number of days of the trip by knowing that the average is 20 miles/day.
- We can find the amount of food needed by planning for 12 pounds/day.
- We can find the proportions of food needed by using Zebulon Hardy's Perfect Proportions.

Essential Understanding #2:

Proportional relationships exist between two variables that vary directly with each other when two variables have a constant ratio between them

Share – As the problem is presented to the students, the teacher should not highlight that the situation is comprised of several proportional relationships. However, as students begin sharing ideas, they will be discussing the variables, possibly without realizing that they are identifying those in a proportional relationship.

Discuss – As the students discuss, listen to the conversations. Are they discussing the map scale? Are they noticing that the Eastern trail has many more safe passages compared to drownings than the Central trail? Are they discussing the rate of 20 miles/day and 12 pounds/day? Are they discussing what to do with 2 parts, 1 part, and $1\frac{1}{2}$ parts?

Analyze – In analyzing, it is important for the teacher to highlight the conversations that were heard and to make a point that students were thinking proportionally as they worked through the problem. The variables can be identified. Did students decide on the trail by comparing drownings to safe passage (part:part) or drownings to all trips (part:whole)? These are subtle, but important, differences in mathematics. When working with Zeb's Perfect Proportions, the parts were obvious; discuss the

importance of finding the total. In wrapping up the problem, consider these questions: Were successful trips always on the same path? Was there such a thing as too much food? Too little? Was there a range in the right amount of food?

Task In Action

The video clips below provide a demonstration of the task being implemented in a classroom as it aligns with the Effective Mathematics Teaching Practice indicated. These clips should be used by the teacher to model the implementation of the task in his or her classroom.

- Implement Tasks That Promote Reasoning and Problem Solving:
 - [Video Clip #1](#)

- Facilitate Meaningful Mathematical Discourse:
 - [Video Clip #2](#)

- Support Productive Struggle in Learning Mathematics:
 - [Video Clip #3](#)