

## Investigation Backpack 03: A One-Day Hike

### COLLABORATIVE PROJECT – UNDER CONSTRUCTION

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Investigation Backpack began in the September 2007 issue of *The Oregon Mathematics Teacher (TOMT)*, the journal of the Oregon Council of Teachers of Mathematics (OCTM).

- OCTM (<http://octm.org/>)
- TOMT (<http://octm.org/TOMT.html>)

In *TOMT*, December 2007, we briefly described two investigations:

- Adventurer's Handbook is described in this document and related documents.
- Piracy and Triangulation is described elsewhere.

For information about investigations that we suggest in **Investigation Backpack**:

- Go to <http://octm.org/TOMT.html> and click on **Investigation Backpack**.
- Go to [www.curriki.org](http://www.curriki.org) and search for **investigation**.
- Send email to **InvestigationBP@aol**.

**Level and Subject:** We ran this investigation for 4th- and 5th-grade students for several years, intertwining math, science, geography, and other disciplines.

**The Hook:** The investigators create a handbook for adventures here and now, or any time and place that they can travel to in our totally terrific time and space machine. We suggest doing it in two parts over a school year.

**Part 1.** Adventures here and now. Teams outfit themselves for hiking, camping, and adventuring. Plan and get ready to go on a one-day hike; two-day hike with overnight camp; longer hiking, backpacking, and camping trip. Introduction, setting the scene, shopping for equipment, map reading, orienteering, survival skills, et cetera, et cetera. Intertwingle math, science, ecology, and other topics in these activities. We use role-playing game techniques (e.g. Dungeons & Dragons) to “go” on simulated hikes, camping trips, and other adventures. Aha! Blend in story telling and creative writing.

**Part 2.** Adventures in time and space. Time-traveling expeditions to interesting times and places. For example, to Beringia 10,000 or more years ago to observe and research the crossing of animals and people from Asia to America over the land bridge that existed at that time. Or to the Moon 10 or so years from now. Or to Mars in, say, Earth year 2030. Or to Middle Earth or Harry Potter's world or to other times and places selected by teachers or students. Reality expands to fill the available fantasies.

## Adventurer's Handbook Collaboration

We'd like to work with you and others to develop Adventurer's Handbook, so we will post files on Curriki as Microsoft Word files that you can download and edit. These files might include:

- Student materials
- Teacher materials
- Tutorial outfitting catalog
- Equipment lists, maps of real and imaginary places, scenarios, math activities, science activities, et cetera, et cetera.
- Tool lists: orienteering protractor, dividers, compass, map distance reader, calculators and units that teach the use of calculators in the context of this investigation, spreadsheets, map-making software, GPS, et cetera, et cetera.

When we did Adventurer's Handbook activities with 4th- and 5th-graders in the 1980s, we met with each class for one period per week for an entire school year. The year-long project consisted of two major parts, as follows:

**Part 1.** Learning about hiking, camping, and adventuring. Planning and getting ready to go on a one-day hike; two-day hike with overnight camp; longer hiking, backpacking, and camping trip; scientific expedition. Introduction, setting the scene, shopping for equipment, map reading, orienteering, survival skills, on and on. Math, science, ecology, and other topics can blend into these activities. The Teacher's Guide will suggest some; teachers can add their favorite topics. We have used role-playing game techniques to "go" on simulated hikes, camping trips, and adventures. This involves students in story telling and creative writing.

**Part 2.** Adventures in time and space. Time-traveling expeditions to interesting times and places. For example, to Beringia 12,000 years ago (some say) or 25,000 years ago (others say) to observe, research, and report on the crossing of animals and people from Asia to America over the land bridge that existed at that time. Or to the Moon 10 or so years from now. Or to Mars in, say, Earth year 2030. Or to Middle Earth or Harry Potter's world or to other times and places selected by teachers or students.

- Bering land bridge ([http://en.wikipedia.org/wiki/Bering\\_land\\_bridge](http://en.wikipedia.org/wiki/Bering_land_bridge))
- MarsBase dot net - Mars Map - Labeled Atlas of the Regions ([www.marsbase.net/m/mars-map.php](http://www.marsbase.net/m/mars-map.php))
- Middle Earth – Wikipedia (<http://en.wikipedia.org/wiki/Middle-earth>)
- Magical objects in Harry Potter ([http://en.wikipedia.org/wiki/Sorting\\_Hat#The\\_Marauder.27s\\_Map](http://en.wikipedia.org/wiki/Sorting_Hat#The_Marauder.27s_Map))

## Prepare to Go on a One-Day Hike

When we did this investigation way back when, we met with each class once a week for an entire school year. Well, sure, it was more like a project than an investigation. We began by preparing and outfitting for a one-day hike. That is an investigation. Hey! A project might be a sequence of investigations of increasing scope, complexity, and other appropriate adjectives.

So, an investigation: prepare to go on a one-day hike away from the habitats of people. What might happen on a 1-day hike? How do you plan the hike? What will you take with you? Here we present a schedule that we used – modify it to fit your style.

### Begin

Organize the class in teams of, say, three or four students. Set the scene. Each team gives itself a cool name and prepares to go on a 1-day hike in an interesting wilderness area, which we describe. We give each team a trail map of the area. They will leave from the **trailhead** at 10:00 AM and return by 6:00 PM. They will hike 10 to 15 kilometers (6 to 8 miles) in easy to moderate terrain, scenic and interesting. Fall, spring, or summer, in good weather, but be prepared for rain.

What will you wear and what will you carry with you? Each team suggests items and writes them on the blackboard/whiteboard under the name of the team. Items are marked as individual items ( I ) or team items ( T ) to be shared. For example, the clothes you wear are individual items. A first aid kit or a pair of binoculars might be a team item. Hand out sheets for recording each team's gear. A gear list worksheet for a team with up to four members might begin like this:

<b>Team name:</b>			<b>Date:</b>
<b>A team member's individual items</b>	<b>A team member's individual items</b>	<b>A team member's individual items</b>	<b>A team member's individual items</b>

Way down yonder ( ↓ ) is a full-page worksheet for individual items. Use a separate worksheet for shared items. Perhaps allocate shared items among team members.

### Continue

Continue making lists of things to wear and take on a one-day hike. Teams compare lists and present their lists to the class. Discuss.

We have seen some amazing lists of gear for a one-day hike! Would you really take a boombox or a portable TV on a one-day hike? Not to mention a cooler full of soda drinks. A cell phone for each hiker? Please not! One cell phone per team to be used only in an emergency is OK. Keep it turned off until needed.

After teams make their lists, hand out lists of **essential stuff** recommended by hiking/camping pros. Search the Internet for 'hiking essentials' or 'camping essentials'. Below we list two classic lists side by side.

REI: Expert Advice – Camping  
[www.rei.com/learn/Camping](http://www.rei.com/learn/Camping)

1. Map
2. Compass
3. Sunglasses and sunscreen
4. Extra clothing
5. Headlamp/flashlight
6. First-aid supplies
7. Fire starter
8. Matches
9. Knife
10. Extra food

Ten Essentials + Four – Backpacking Gear  
[www.backpacking.net/ten-essl.html](http://www.backpacking.net/ten-essl.html)

1. Map
2. Compass
3. Flashlight / Headlamp
4. Extra Food
5. Extra Clothes
6. Sunglasses
7. First-Aid Kit
8. Pocket Knife
9. Waterproof Matches
10. Fire starter
11. Water / Filter / Bottles
12. Whistle
13. Insect Repellents or Clothing
14. Sunburn Preventatives

REI has an **Updated Ten Essential "Systems"** list at

[www.rei.com/LearnShareDetailArticlesList?storeId=8000&categoryId=Camping&url=rei/learn/camp/clessentialsf.jsp](http://www.rei.com/LearnShareDetailArticlesList?storeId=8000&categoryId=Camping&url=rei/learn/camp/clessentialsf.jsp)

- |                                |  |
|--------------------------------|--|
| 1. Navigation                  | Map and compass. Optional: GPS                           |
| 2. Sun protection              | Sunglasses, sunscreen, protective clothing               |
| 3. Insulation (extra clothing) | Hat or balaclava, clothing according to season           |
| 4. Illumination                | LED headlamp recommended                                 |
| 5. First-aid supplies          | First-aid kit and book                                   |
| 6. Fire                        | Waterproof matches or waterproof container, fire starter |
| 7. Repair kit and tools        | Knife, multi-tool, duct tape                             |
| 8. Nutrition (extra food)      | Energy bars, nuts, dried fruit, jerky                    |
| 9. Hydration (extra water)     | Water bottle, filter, purifier, chemicals                |
| 10. Emergency shelter          | Ultralight tarp, bivy sack, or emergency space blanket   |

## Update gear lists

Teams use the lists of essential stuff to update their individual and team gear lists.

## Estimate cost and weight

Teams **estimate** the cost of each item on their individual and shared lists and use the estimates to **calculate** the total cost for individual items and shared items. They also estimate the weight of each item and use the estimate to calculate the total weight. Calculators and spreadsheets are appropriate technology for this activity.

## Shop for hiking gear in camping catalogs or online

Outfitting begins with structured "shopping" in camping catalogs or online. In the 1980s we used paper catalogs. Each team got a catalog and order blanks to use in shopping for individual items and separate order blanks to shop for shared items. We used the following catalogs:

- Campmor, POB 700, Saddle River, NJ 07458-0700 ([www.campmor.com](http://www.campmor.com)). A very complete catalog. A 240-page paper catalog is available. Order it at the web site.
- Recreational Equipment, Inc. (REI), 1700 45th Street East, Sumner, WA 98390 ([www.rei.com](http://www.rei.com)). Shop online.

Students learn how to:

- Shop from a catalog, or shop online.
- Use the catalog's index.
- Fill out an order blank.
- Calculate price and weight.
- Find and use information presented in tables.
- et cetera, et cetera.

As part of this package, it would be terrific to create a **tutorial catalog** that contains math & science information, tables of data, and other stuff that relates math & science to hiking, camping, and adventuring. In the meantime, here are some online tutorials:

- Howstuffworks "How to Hike" (<http://health.howstuffworks.com/how-to-hike.htm>)
- REI: Expert Advice ([www.rei.com/learn/Camping](http://www.rei.com/learn/Camping))
- Hiking Trailhead ([www.hikingdude.com/hiking-trailhead.shtml](http://www.hikingdude.com/hiking-trailhead.shtml))
- Hiking Web Site - Hiking Information ([www.hikingwebsite.com/hiking/index.htm](http://www.hikingwebsite.com/hiking/index.htm))
- Outdoor Gear Reviews: Backpacking and Hiking Gear ([www.trailspace.com/gear/](http://www.trailspace.com/gear/))

## Volume Estimation and Calculation Alakazam

Students will soon start shopping for gear, beginning with a **daypack** to carry the gear on the hike. A daypack typically has a volume of 25 to 35 liters (1500 to 2100 cubic inches). Before shopping for a day pack, we do a volume estimation activity.

We use an empty box of the type that holds 10 reams of copy or printer paper. The inside dimensions are about 17.3 in  $\times$  11.1 in  $\times$  10.0 in.

- Volume = (17.3 in)(11.1 in)(10.0 in) = 1,920 cubic inches.

1,920 cubic inches is in the volume range for a daypack.

The picture shows a case of 10 reams of 50% recycled printer paper from Staples ([www.staples.com](http://www.staples.com)).



We also bring an inch cube. Each student **estimates** the inside volume of the box in cubic inches and records the estimate on a worksheet. We call this the **wild-stab volume**. The team discusses the estimates, and agrees on a team wild-stab estimate.

Next: Each student **estimates** the length, width, and height of the box in inches and uses the estimates to calculate an estimated volume. We call this the **calculate-using-estimated-dimensions volume**. The team discusses the individual estimates, and agrees on a team estimate.

Onward: Each team uses a yardstick to measure the box and calculates its volume. We call this the **calculate-using-measured-dimensions volume**. The team discusses the individual measurements and calculations, and agrees on a team value.

Now compare the wild-stab volume, the calculate-using-estimated-dimensions volume, and the calculate-using-measured-dimensions volume. Possibilities:

- Each team makes a bar graph of its three volumes. Compare graphs among teams.
- For each type of volume, make a bar graph of that type of volume for all teams.
- Assume that the calculate-using-measured-dimensions volume is closest to the actual volume. Calculate the percent difference of the two estimated volumes.

We think that we have three levels of accuracy here:

1. Wild-stab estimate: Look at the box, look at the inch cube, and estimate the box's volume in cubic inches. Probably the least accurate with a big range of values.
2. Estimate the length, width, and height of the box and then use these estimates to calculate the box's volume. Probably more accurate than the wild-stab estimate.
3. Carefully measure the box's inside length, width, and height, and then use these measurements to calculate the volume. Hopefully the most accurate.



## Shop for a daypack

A daypack typically has a volume of 25 to 35 liters (1500 to 2100 cubic inches). We have several daypacks. For a 1-day hike, we usually use our 20-year old, 30 liter (1800 cubic inches) daypack that has a main compartment and three outside pockets.

The picture shows a North Face Borealis II daypack. It has a main compartment, two outside pockets with zippers, and two mesh side pockets for water bottles. Volume: 1850 cubic inches (about 30 liters). Read about this and other daypacks at **Campmor** ([www.campmor.com](http://www.campmor.com)). Start filling out an order blank.

Item	Qty	Price each	Price total	Weight each		Weight total	
				lb	oz	lb	oz
North Face Borealis II daypack, 1850 in <sup>3</sup>	1	49.97	49.97	2	1	2	1

**Disclaimer:** We have not used the North Face Borealis II daypack, so don't know if it the right stuff. We chose its picture from the cornucopia of daypack pictures at [www.campmor.com](http://www.campmor.com) because it is about the right size, has a main compartment and outside pockets, and shows two water bottles nestled in their mesh side pockets.

## Structured shopping: hiking boots and socks

Before turning students loose for unstructured shopping, we guide them in shopping for hiking boots and socks, the foundation of hiking. We recommend that students “buy” one pair of boots (discussion of pros and cons) and two or more pairs of socks (discussion of pros and cons). Give your feet a treat: change socks on the trail. Oops! Fell into the creek – put on dry socks. We do this together and add the new items to the order blank. Ours looks like this:

Item	Qty	Price each	Price total	Weight each		Weight total	
				lb	oz	lb	oz
North Face Borealis II daypack, 1850 in <sup>3</sup>		49.97	49.97	2	1	2	1
hiking boots designed for moderate hiking	1	79.99	79.99	2	10	2	10
socks designed for mild weather hiking	3	12.99	38.97	0	2	0	6

## Unstructured shopping begins

Students shop for individual items and add them to their order forms. The teacher wanders about, answers questions, makes suggestions, and adds his or her flavor to the hum of activity.

How do teams organize this? One way is to continue the order blanks shown above by buying the clothes you will wear.

We suggest **convertible pants**, the ones that have zip-off legs above the knee. If it is warm, zip off the legs and – presto! – wear shorts. If it turns a bit chilly, zip the legs back on.

Item	Qty	Price each	Price total	Weight each		Weight total	
				lb	oz	lb	oz
North Face Borealis II daypack, 1850 in <sup>3</sup>		49.97	49.97	2	1	2	1
hiking boots designed for moderate hiking	1	79.99	79.99	2	10	2	10
socks designed for mild weather hiking	3	12.99	38.97	0	2	0	6
convertible pants	1	29.99	29.99	0	10	0	10

On a warm day, you will probably wear some clothes that you already have, such as a T-shirt. If your hike might involve a bit of timber-bashing, it would be good to don a long-sleeved shirt before you crash your way into the dense woods. Beware ticks, poison oak, and other denizens of the jungle waiting to pounce on you. We suggest that you wear, or carry in your daypack, a long-sleeved shirt designed for hiking.

- Go to [www.campmor.com](http://www.campmor.com) and search for 'ventilated shirt'.

We added this shirt to our order blank and then did a "bottom line" calculation.

Item	Qty	Price each	Price total	Weight each		Weight total	
				lb	oz	lb	oz
North Face Borealis II daypack, 1850 in <sup>3</sup>		49.97	49.97	2	1	2	1
hiking boots designed for moderate hiking	1	79.99	79.99	2	10	2	10
socks designed for mild weather hiking	3	12.99	38.97	0	2	0	6
convertible pants	1	29.99	29.99	0	10	0	10
ventilated shirt from <a href="http://www.campmor.com">www.campmor.com</a>	1	29.99	29.99		9	0	9
<b>Total price and total weight</b>	6		228.91			4	36
<b>Total weight adjusted so that ounces &lt; 16</b>	6					6	4

Aha! An opportunity to do ugly arithmetic imposed by the weird system of units used in the USA. 36 oz equals 2 lb, 4 oz. So 4 pounds, 36 oz is equal to 6 lb, 4 oz.

**Shop for essential items.** Here is a handy order blank of items from REI's updated list.

Item (REI updated list)	Qty	Price each	Price total	Weight		Weight total	
				lb	oz	lb	oz
1. Navigation							
map							
waterproof map case							
compass							
2. Sun protection							
sunglasses							
sunscreen (lotion or cream)							
hat (sun/rain, 360° brim)							
3. Insulation (extra clothes)							
waterproof windbreaker							
balaclava							
poncho (ultra light weight)							
gloves							
4. Illumination							
LED headlamp (recommended)							
LED flashlight							
5. First aid supplies							
personal first aid kit							
6. Fire							
waterproof matches							
waterproof match container							
fire starter							
7. Repair kit and tools							
repair kit							
Swiss Army Knife or multi-tool							
8. Nutrition (extra food)							
trail mix							
energy bar							
9. Hydration							
water bottle							
water purification tablets							
water filter or purifier							
10. Emergency shelter							
bivy sack							
survival blanket							
<b>Total price and total weight</b>							
<b>Total weight adjusted so that ounces &lt; 16</b>							



## Continued (**Under construction – add your stuff and post at Curriki**)

**Continue shopping** until gear lists are complete, order blanks are completed, total price and weight are calculated, et cetera, et cetera. When we did this investigation in the 1980s, we put limits on total cost and total weight. What is a good weight limit for, say, a 5th-grader?

**Plan a hike.** Indeed, plan two or three or more hikes. Use a trail map that shows distances and elevations. Calculate the slope and distance of each **trail segment** and create a timetable for the hike. Make it real – we found that students overestimate how fast they can walk on a hike.

- Level segment, slope = 0. What speed can your students maintain? (1 m/s = 2.237 mph)
- Up a gentle slope (< 0.05 or < 5%). What speed can your students maintain?
- Up a steep slope ( $\geq 0.05$  or 5%). The steeper, the slower.
- Down a gentle slope. Dangerous to jog or run!
- Down a steep slope. Very dangerous to jog or run!

When, where, and for how long will you stop for lunch? Where and for how long might you tarry in an interesting place, or to enjoy a beautiful vista?

We planned hikes in nearby State Parks, went by school bus to a park, and did one of the hikes live. That's another story for another time.

We also did a **simulated hike** using a trail map of the Bumpass Hell trail in Lassen National Park. Great hike! Go fish:

Bumpass Hell | CA: Northern California Hikes  
[www.trails.com/tcatalog\\_trail.asp?trailid=HGS406-006](http://www.trails.com/tcatalog_trail.asp?trailid=HGS406-006)

Bumpass Hell's evocative name suits it perfectly. Like its moniker, this geothermal area is a combination of the whimsical and the ominous. Fantastically colored superheated water swirls and bubbles in large pools, and burping mudpots are endlessly entertaining, but columns of hot steam and the wickedly rotten scent of volcanic gases (not to mention the numerous warning signs posted alongside boardwalks) are vivid reminders of the violence of the area. Highlights: This trail leads to a large, colorful hydrothermal area that is arguably the most spectacular in the park.

First we planned the hike and created a timetable. Then we "went" on the hike using role-playing game methods. [The best-known role-playing game is *Dungeons & Dragons (D&D)*.] Great fun! That too is another story for another time.

### Continue with

Map reading and orientation skills

Each team creates and presents a simulated 1-day hike

Planning and outfitting for a 2-day hike with an overnight camp

Science and math experiments related to hiking, camping, and adventuring

Lots more!

**Gear list worksheet for a team of up to four members.**

<b>Team name:</b>			<b>Date:</b>
<b>A team member's individual items</b>	<b>A team member's individual items</b>	<b>A team member's individual items</b>	<b>A team member's individual items</b>