The Mountaineers
EXPLORE • LEARN • CONSERVE

Navigation Northwest

A Quarterly Newsletter of the Seattle Navigation Committee
Volume 3, Number4 **December 2015**

--Navigation Northwest December Features--

Wilderness Navigation Instructor Training January 13

By Paul Thomsen

Mountaineers considering volunteering to instruct at the upcoming Wilderness Navigation Workshops (Jan 28/Feb 9 & 25/Mar 3 & 29) and/or Field Trips (Feb 13/Mar 12 & 13/Apr 3) are strongly encouraged to enroll in the free Instructor Training Wednesday, January 13 from 6:30 to 8:30 pm. An online, on-demand course is under development but will likely not be released until February or March.

This hands-on workshop prepares you with teaching techniques, tools, and tricks of the trade for the new Wilderness Navigation course. New instructors are encouraged to attend, but it's not required. Even experienced Navigation instructors should find this course useful given that some substantial changes were introduced to the workshop and fieldtrip in early 2015.

We'll review the Workshop problem set from an instructor's point of view, and we'll also discuss key points you should cover with your small group during the Field

Trip. We'll also talk about UTM in more detail. Please bring USGS Baring and Index maps, compass, Smart Phone (if you have one), altimeter and GPS (if you have them), pencil, and paper for taking notes.

In order to attend you need to be a Basic Navigation Course graduate, but if you're not then you'll need to contact the Seattle Navigation Committee Chair to apply for special permission.
--Paul Thomsen leads the instructor training division and is a veteran Seattle Navigation Committee member.

Branch Participation Sought for February Launch of "Wilderness Navigation" eLearning Course

By Peter Hendrickson

The Board of Directors October 1 approved a release of bequest funding for a navigation elearning 2016 pilot. Seattle Navigation is striving to complete revised documents no later than January 1 to accelerate development. The online student workshop is being designed to work for all branches, and at this writing, both Seattle and Kitsap are intending to offer it. All branches are encouraged to contact Peter Hendrickson (p.hendrickson43@gmail.com) Seattle Branch Chair and pilot committee member, to learn more about how they can offer the course. In addition to Hendrickson, the pilot steering committee includes, Doug Canfield, project manager (Mountaineers Books Director of Sales & Marketing), Tab Wilkins (alpinist & past BOD chair), and Margaret Sullivan (Books Managing Editor).

The goals for the pilot are to serve students who may not live near a physical course location or who prefer to take the workshop at their own pace; to assist instructional volunteers with a fully vetted and packaged curriculum; and to make it easier to recruit instructional volunteers.

There are three deliverables:

1. A series of 4 to 6 navigation skills videos available to all who access The Mountaineers website. Hendrickson, immediate past Seattle Navigation Chair, is writing the scripts. Another team of four Seattle Branch navigation leaders (Greg Testa, Brian Starlin, Bruce Crawford and Lynn Graf) serve as technical consultants for the videos and other aspects of the project. Suunto of Finland is also underwriting some of the video expenses. Many Mountaineers use Suunto hand-bearing compasses and wristwatch ABC (Altimeter, Barometer, Compass) tools.

2. An on-demand instructor training course for both the elearning and the in-person course options. Seattle lead training instructor Paul Thomsen consults on this project.

3. An on-demand Wilderness Navigation workshop suitable for all branches with unique ties to each branch's field trips. Current plans call for a February launch to align with March and April fieldtrips.

Trillium Publications of Shoreline & Chicago is the contractor for instructor training and the workshop. Weekly conference calls are moving forward the design, drafting and execution of the project. A video contractor search is underway.

As reported last issue, both the substance and the delivery of the Wilderness Navigation Workshop are changing. Following are highlights:

- The course is targeted for climbers, scramblers, back country hikers and wilderness skiers/snowshoers. Those wishing front country, on-trail instruction are guided to "Introduction to Map & Compass" or "Staying Found".

- Pre-trip navigation planning is emphasized with homework before both the workshop and field trip that goes beyond carrying the 10 Essentials. The online offering will embed activities and quizzes to support the planning.

- Altimeters are used as a third leg of the Map-Compass-Altimeter tools triangle. Basic point position use of GPSers is expected but more thorough instruction is saved for the GPS course. There is opportunity to include links to apps in the online course.

- Students are encouraged to bring their Smart Phones with free or nearly free altimeter and GPS/UTM apps. At minimum, instructors will demonstrate appropriate use and risks of these tools. More complete instruction will continue through the basic GPS course.

- The new problem set integrates altitude and GPS/UTM information from the expanded tool set. The Baring Quad will be the focus for the workshop. The Seattle Branch will continue using the Index Quad for its field trip but other branches will use quads related to their sites.

- Line and point position are emphasized with triangulation taking a minor role.

Do Cheap Altimeters Work as Navigation Tools?

A Navigation Northwest Gear Review

> *"Since mountains are not two-dimensional...the altimeter is sometimes as helpful as the compass, particularly where topographic maps are available. With* ***altitude known*** *point-position can often be found with only one visible feature recognized; in any other case, altitude provides a check against map and compass orientation."*
>
> **Mountaineering: The freedom of the hills, 1st ed. 1960, p. 79**

By Steve McClure

Early altimeters with 19 jewels and Swiss-made movements were price-prohibitive and thus weren't included in either the Mountaineers navigation courses or the Ten Essentials. In October some 70 navigation students took the newly named Wilderness Navigation class (FKA Basic Navigation). The class has been updated by the Seattle Navigation Committee with input from several branches, and guided by the results of the June 2015 Navigation Summit. The course now prominently features the altimeter and lays a solid foundation for GPS use. For the upcoming 9th edition of *Freedom of the Hills*, navigation, the first of the Ten Essentials, will feature map, compass and all of the modern tools with altimeters prominent among them.

The Challenge

Now that Swiss jewelers are no longer needed to make an altimeter, *just how cheap can we go?* It's easy to spend $130 to $350 on a Suunto Core ABC (altimeter, barometer & compass) watch. But how functional is a ~$30 Casio multifunction watch? Or cheaper still, how functional are the many, free cell phone apps?

It was a little awkward to wear three wrist altimeters and more awkward still to ask my spouse and climbing partner to wait in a snowstorm on the Muir snowfield while I recorded data. But the results are in and they are clear. The cheapos work great. I can highly recommend at least one cheap watch and a handful of mostly Android cell phone apps.

The Test

I tested three wrist altimeters and six apps on my Samsung Galaxy S5 smartphone. The S5 has a built-in

altimeter chip as do the latest iPhone 6 models. The apps were picked were free and strongly rated. For wrist altimeters I used my 15+ year old Suunto Observer, a new Suunto Core, and the cheapest altimeter I could find on Amazon—the "Casio SGW300H-1AVCF Twin Sensor Multi-Function Digital Sport Watch." In addition to the six apps from the Android Play Store (https://play.google.com) I performed a cursory test of three iOS apps (http://itunes.apple.com) with similar results. See Table 1 for tool details. In the end, tool choice made no material difference.

These tools use three, quite different methods to determine altitude. The traditional method measures atmospheric pressure, as do barometers, but calibrated in feet rather than inches of mercury (or meters vs. millibars). Since weather affects air pressure, and therefore apparent altitude, these tools must be calibrated at the start of a trip and perhaps during. I calibrated them at the trailhead to a known elevation and made no further adjustments.

Tools that determine altitude using GPS use two quite different methods. The first GPS altitude method takes the absolute position in 3D space and compares it to a math model (the ellipsoid) that approximates mean sea level. GPS technology has taught us that the sea isn't as level as we thought and undulates considerably around the world. Using a built-in table, modern GPS units then correct for the difference between the ellipsoid and local mean sea level. Early GPS units did not make this adjustment. Perhaps this is one reason GPS units have an undeserved bad reputation for determining elevation.

The other way GPS determines altitude is to assume that you are standing on the surface of the earth (a bad assumption for pilots in flight). The tool then uses GPS coordinates to find elevations in a lookup table. An Internet connection is required so this is not practical for wilderness navigation. If the Internet is not available, these apps default to the 3D method.

Table 1. Altimeter tools tested

Tools	**Comments by Author**
	Wrist Altimeters
Suunto Observer	This approximately 15-year-old altimeter watch has been my constant companion for a long time. The cost was about $300.
Suunto Core ALU	This is a new watch in 2015. The current Amazon cost is

Pure White	$220.
Casio	This is a new watch in 2015. The current Amazon cost is $33.

	Android Apps
Gaia (Android ver.)	$20. My go-to most-highly-recommended navigation tool for backcountry and world travel.
Accurate Altimeter Free (ver. 1.15)	Free or $1.49. Interestingly show altitude using three different methods.
DS Altimeter	Free. Interestingly show altitude using four different methods.
Runtastic Altimeter & Compass	Free. Very slow.
GPS Test	Free. In addition, this app gives you the detailed status of the GPS fix including showing both GPS and Russian Glonass satellites.
GPS Essentials	Free. In addition, this app provides a wide variety of other functions including sun/moon rise/set, position, bearing, and speed

	iOS Apps
Gaia (iOS ver.)	Same comments as for Android version.
Travel Altimeter Lite	Free
My Altitude	Free

Methods

The test was simple. I took all eight tools on four trips: three at in Mt. Rainier NP (a glacier climb to Whitman Crest below Little Tahoma, a climb to Anvil Rock near Camp Muir and a hike to Mildred Point) and one hike to the summit of San Jacinto Peak near Palm Springs, CA. I took measurements along the way and then compared with a gold standard "actual" elevation based on GPS location.

While we might like to know elevation with great precision, mountain navigation is tolerant of several hundred feet of deviation. The bold topographic index lines on a 1:24000 (7.5 minute) USGS map are 200 vertical feet apart so I set two criteria for success:

1) Each individual altitude measurement does not deviate more than 300 feet from actual. As long as all measurements are within 300 feet (150% of the distance between bold lines) of actual, you will not be more than one bold

line off from the actual nearest bold line. This is not a potential 600-foot error.

2) The average altitude measurement is within 100 feet. Ideally, the altimeters would, on average, put you on the correct bold map line.

I assumed that some of the apps or the $30 Casio special would produce material errors, especially over large changes in altitude.

Ain't Misbehavin'

For these three trips, I could not get any of the wrist altimeters or apps to misbehave, with two exceptions that I'll address below. Each device's worst individual reading was within my criterion of success of +/-300 ft. with the worst individual reading varying by 259 ft. On average, the tools were almost ridiculously accurate with the worst average difference being only 60 ft. This was surprising especially considering one of the trips was over two days with an elevation difference of 5400 feet.

While all the tools performed exceptionally, the GPS apps were more accurate. If the barometric altimeters had been recalibrated, as recommended for a normal trip, they would have been even more competitive.

Using GPS for elevation data tends to raise eyebrows but the data says this reputation is undeserved. The data allowed me to test this question in addition to the main topic of this paper. I compared Gaia GPS, my go-to favorite navigational tool with actual elevation data. I was able to take 14 measurements in diverse locations from the San Jacinto Mountains of southern California to Calgary, Canada. Table 2 compares the Gaia GPS measurements against good map data.

Table 2. Gaia measures compared to topo map elevations.

	N=	Average Difference	Maximum Difference
Gaia (Android ver.)	10	-41 ft.	+101 ft.
Gaia (iOS ver.)	4	-52 ft.	-136 ft.

A few cautions are in order. There were two anomalies that surfaced during testing, both with wrist altimeters. On the summit of San Jacinto Peak it was below freezing. When I took the watch off my wrist to use the built-in thermometer, the temperature plummeted until it hit 35F and then shot up to over 200F. The altitude, which had shown a reasonable 10,800 ft., shot up to 27,400 ft. If anyone can explain this, please let me know. When the altimeter was back on my wrist, readings returned to normal.

The second anomaly was with the Suunto Core. This watch has large buttons that protrude. There is a locking mechanism that I had not engaged and on one trip, the buttons were accidently pushed and the watch adjusted to the wrong altitude. I left this data out of the results.

Also, remember that smartphones are fragile, power-dependent electronics so get a credible case, turn it off (or to airplane mode) between uses and have a map, compass and backup tools. Wristwatch altimeters and apps that rely on atmospheric pressure are subject to changes in weather. Keep that in mind and recalibrate when the altitude is known (map position) or recalibrate against GPS which is unaffected by weather. There were no dramatic changes in weather and I did no recalibration during the tests.

Table 3. Field test results dedicated altimeters and Android apps

Navigation Tools Tested:	Method:			Deviation:			Pass/ Fail
	Atmospheric Pressure	GPS vs. Ellipsoid	GPS Lookup	Avg.	Max.	N=	
Wrist Altimeters:							
Suunto Observer	✓			28 ft.	259 ft.	11	**Pass**
Suunto Core	✓			-11	204	11	**Pass**
Casio ($33) Special	✓			-60	172	11	**Pass**
Android Apps							
Gaia (Android ver.)		✓		12	82	11	**Pass**
Accurate Altimeter Free (1.15)	✓	✓	✓	-31/29	112/138	11	**Pass**
DS Altimeter	✓	✓	✓	-7/-27	143/161	11	**Pass**
Runtastic Altimeter & Compass		✓		-26	103	11	**Pass**
GPS Status		✓		-17	78	11	**Pass**
GPS Essentials		✓		2	80	11	**Pass**
Target Maximum Deviation Less than:				**+/- 100'**	**+/- 300'**		

Table 3 Note: Average and maximum deviation is the difference between the tool and the actual known elevation as determined by the Google elevation service. Where the tool uses both atmospheric pressure and GPS, each is shown with the atmospheric first followed by GPS to the right of the slash.

Take this study as a strong recommendation to add an altimeter (or two!) to your navigation tools. A cheap Casio wristwatch altimeter will run for years on one battery and if you have a smart phone, add a free app. Or, better yet, add Gaia GPS for $20 and have a world-class navigation tool in your pocket.

--Steve McClure sits on the Mountaineers Board of Directors as Treasurer, chairs the Finance Committee, and sits on the Seattle Climbing, Scrambling, and Navigation committees. He is an intermediate climbing student. Contact him at McNorth@Gmail.com.

--Ed's Note: The Seattle Navigation Committee invites prospective gear reviewers to submit requests to test new navigation tools. The Committee will reimburse the reviewer for the tool and offer it to the reviewer to keep at a 50% discount. Submit your brief (1 page) review proposal to the editor. Specify your experience, committee(s) affiliation, tool, source, cost and review procedures in your proposal.

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How Do We Integrate Nature with Technology?

By JaLynn Montes and Erin Norman

We explored the ways in which mobile, digital technology is integrated into outdoor learning experiences, specifically for adult learners. We wanted to know what kinds of mobile technology educators in the field utilize and how this technology impacted the learner's experience.

As Western Washington University graduate students (Adult and Higher Education) we anonymously surveyed nine instructors from Seattle and Bellingham organizations who use mobile technology in outdoor settings. Seattle Branch Mountaineers navigation instructors in participated. Some focused on the use of GPS in the navigation courses.

Following is a link to a website which displays the findings:
http://mobiletechnologyandoutdooreducation.weebly.com/
A display from the Weebly website follows.

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MOBILE TECHNOLOGY &
OUTDOOR EDUCATION

INTEGRATING NATURE WITH TECHNOLOGY

We asked local outdoor instructors how they use mobile, digital technology in their outdoor learning classes. Below are some of the most prominent themes that emerged from their answers.

MATCHING THE TOOLS TO THE SKILLS

Most of the mobile, digital tech being used by outdoor educators is for navigation and tracking purposes: GPS, altimeters, and navigation apps for smartphones. The next most popular tech tools are for observation, documentation, and artistic expression: digital cameras and smartphone cameras and apps for recording observations.

JaLynn and Erin are WWU graduate students. JaLynn is a veteran ESL teacher and Erin a gardener. Contact JaLynn at augustj3@students.wwu.edu.

Wilderness (Basic) Navigation Course Offerings 2016--Seattle

Basic Navigation transitions to Wilderness Navigation in 2016, clearly focused on wilderness/back country travel including off trail navigation to meet requirements for Alpine Scramble, Basic Climbing, Snowshoe and BC Ski students (and others). Altimeters and GPS units (basic point position) are included. We hope to partner with Foothills Branch to help staff Staying Found, an on-trail/front country, less physically rigorous course on West Tiger Mountain off I-90 near Issaquah. Staying Found does not meet other back country course requirements.
https://www.mountaineers.org/about/branches-committees/seattle-branch/committees/seattle-navigation-committee/course-templates/basic-navigation-course/basic-navigation-course-seattle-2016

Date & Day	Workshop	Date & Day	Fieldtrip
Wed, Jan 13, 2016	**Instructor Training**		
Thur, Jan 28, 2016	Program Center		
Tues, February 9	Program Center	Sat, February 13	Heybrook Ridge
Thur, February 29	Program Center	Sat, March 12	Heybrook Ridge
Thur, March 3	Program Center	Sun, March 13	Heybrook Ridge
Tues, March 29	Program Center	Sat, April 2	Heybrook Ridge
Thur, Nov 3	Program Center	Sat, Nov 5	Heybrook Ridge

Smart Phone and Dedicated GPS Navigation Course--Seattle

Are you interested in learning to use your smart phone as a wilderness GPS? Maybe you have had a dedicated GPS for years and want to get the most out of it? The Smart Phone and Dedicated GPS Navigation course is for you! We will cover basic usage of both dedicated GPS units and some select GPS apps for smart phones, as well as common issues that can affect GPS accuracy and ways to avoid them. This course is an evening at the Mountaineers Seattle Program Center in Magnuson Park, split between a classroom lecture and a hands on outdoor exercise. This course is open to Wilderness (Basic) Navigation students and graduates.

Topics include:

- Overview of how GPS works
- Common accuracy issues and solutions
- Review of UTM coordinates
- Entering waypoints
- Navigating to a way point
- Back tracking a route
- Overview of emergency locating beacons (SPOT, PLB)

Students need to bring a GPS enabled device to the class; loaners are not available. We cover both Gaia for iOS and Android devices ($20, pro not required)

and Garmin dedicated units. Other brand GPS units are welcome, but instructors may not be familiar with them.

Lead course administrator is Brain Seater for the six annual classes.

The current URL provides a description and the 2016 dates are on the calendar: https://www.mountaineers.org/about/branches-committees/seattle-branch/committees/seattle-navigation-committee/course-templates/smart-phone-dedicated-gps-seattle/smart-phone-dedicated-gps-seattle-2016

Smart Phone & Dedicated GPS Course	Location
Thursday, January 21, 2016	Seattle Program Center
Monday, April 18	Seattle Program Center
Thursday, May 12	Seattle Program Center
Monday, June 20	Seattle Program Center
Tuesday, August 9	Seattle Program Center
Thursday, October 6	Seattle Program Center

Introduction to Map & Compass—Getting Started--Seattle

The Seattle Navigation Committee has scheduled six 2016 Introduction to Map and Compass dates at the Seattle Program Center from 6:30 to 8:30 p.m. Instructors are drawn from the pool of Basic Navigation Course teachers. You can enroll at: https://www.mountaineers.org/about/branches-committees/seattle-branch/committees/seattle-navigation-committee/course-templates/introduction-to-map-compass/introduction-to-map-compass-seattle-2016-1. Administrative lead is Brian Carpenter. This Getting Started introductory class does not satisfy the navigation requirement for Alpine Scramble, Basic Climbing, Snowshoe or Backcountry Ski.

Introduction to Map & Compass 2016	Location
Tuesday, January 12, 2016	Seattle Program Center
Thursday, April 14	Seattle Program Center
Tuesday, May 10	Seattle Program Center
Thursday, June 16	Seattle Program Center
Monday, August 15	Seattle Program Center
Thursday, September 22	Seattle Program Center

Other Branches 2016 Navigation Courses

Branch	Course	Dates
Kitsap	Basic Navigation Course Seminar	February 17
Kitsap	Basic Navigation Course Field Trip	February 25
Tacoma	Wilderness Navigation Lectures 1 & 2	April 7 & 14
Tacoma	Wilderness Navigation Field Trip	April 16
Tacoma	Wilderness Navigation Lectures 1 & 2	May 3 & 10
Tacoma	Wilderness Navigation Field Trip	May 14

Tacoma	Wilderness Navigation Lectures 1 & 2	August 10 & 17
Tacoma	Wilderness Navigation Field Trip	August 20
Olympia	Basic Navigation Course Lectures	April 12, 14
Olympia	Basic Navigation Course Field Trip	April 16, 17
Olympia	Basic Navigation Course Lectures 1 & 2	April 12 & 14
Olympia	Basic Course Field Trips	April 16 & 17
Foothills	Staying Found—For Hikers & Backpackers	April 9
Foothills	Staying Found—For Hikers & Backpackers	May 14
Foothills	Staying Found—For Hikers & Backpackers	June 11

Navigation Project

>>Our Seattle Volunteer Park effort to create a self-guided navigation map, compass, and SmartPhone (altimeter & UTM coordinates) practice course is now online. You may download the PDF (with answers) here https://www.mountaineers.org/about/branches-committees/seattle-branch/committees/seattle-navigation-committee/files/seattle-navigation-self-guided-practice-volunteer-park/ Ideally, the budding wilderness navigator would work through many of the problems at home prior to walking about the Volunteer Park stations—about an hour for each part. Suggestions for free or nearly free SmartPhone GPS and altimeter apps are included
--Editor

Links, Apps, Gear of Interest

Your comments and suggestions are ever welcome regarding the Seattle Navigation website and links in Navigation Northwest.

The Gear…

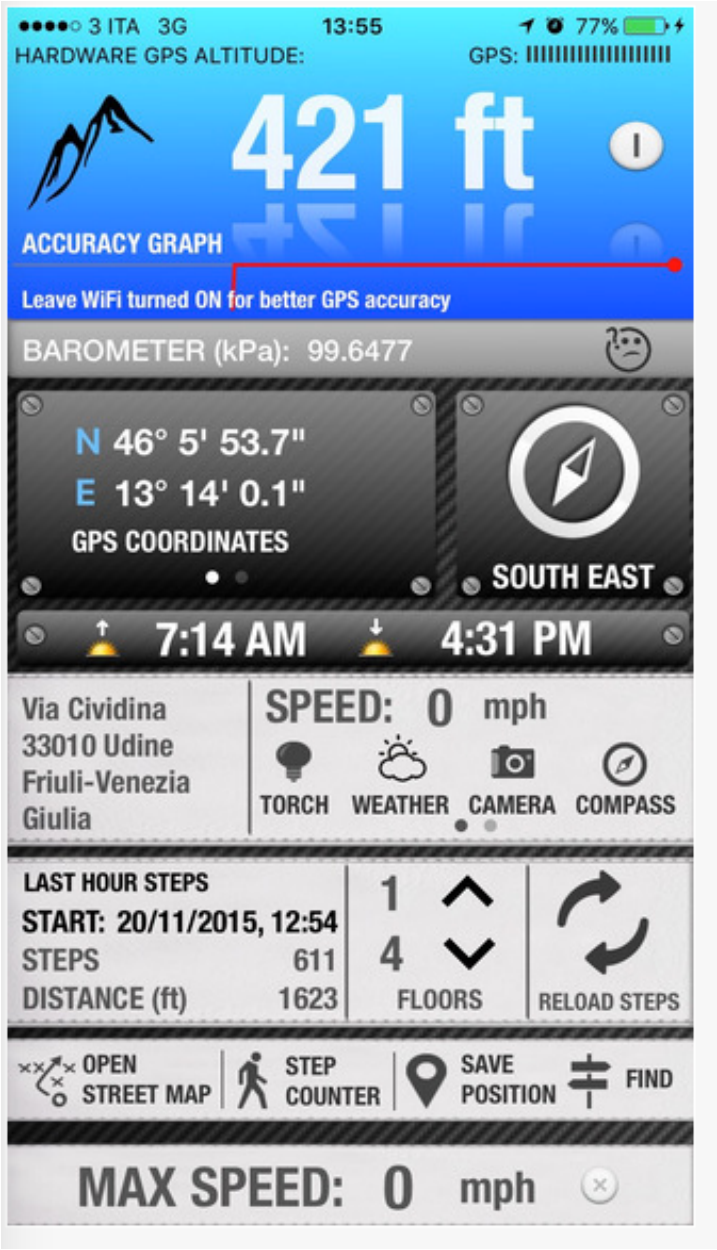
- Anker battery pack—My iPhone 5s power drain was quicker than anticipated on a September kayak camping trip in Northern Maine. A longtime friend loaned me juice from his Anker battery pack. An hour later I was good for the rest of the week. Bought a ~$30/10.9 oz. Anker 2nd Gen E5 16000 mAh portable, 2-port for iPhone 6+/5S-5C-4S/iPad Air/many others. Strong reviews in Amazon. With 3 amp output, it charges quickly—up to 6 iPhone 5S (3.5 Galaxy S5) charges—this could work for a party. Beats my old NiCad rechargables. Recharge in 8-9 hours using a 2 amp or higher output device—phone chargers much slower. --Editor

The Apps…

- Theodolite for iOS—Version 5.0 for iPhone and iPod touch (https://itunes.apple.com/us/app/theodolite/id339393884?mt=8) and Android (http://www.appszoom.com/android-apps/theodolite). I've been playing with this iOS version on an iPhone5S which provides UTM (Lat, Long shown here), Altitude and time plus a heading, horizon angle and slope (elevation angle). Perhaps we'll include screen shots—camera controls are easy to use—in our online Wilderness Navigation workshop.

What a fine way to document views from locations along your path. My only complaint is that the header information sometimes disappears into the background. About $6. --Editor

Altimeter GPS Pro 4.0 (https://itunes.apple.com/us/app/altimeter-gps-pro-elevation/id545185104?mt=8) provides a simple, bold display of the GPS determined altitude. One touch toggle meters/feet; coordinates only in Lat, Long; compass for cardinal points; auto sunrise/sunset; auto current street address; light/weather/camera; and on trail features; finger swipe displays Open Street Map (OSM) of current position. Cost: Free or $0.99. --Editor



And the links...

- Altimeter watch navigation advice from the UK's Alpine Guides. http://www.alpine-guides.com/mountaineering/advice/altimeter-watch-advice.htm
- New Yorker's American Chronicles: The Wayfarer, by Ben McGrath. A solitary canoeist meets his fate. Navigating afloat with automobile maps—a geezer tale. http://www.newyorker.com/magazine/2015/12/14/the-wayfarer
- How to give the best give directions (without iron in your nose? A study: http://www.csmonitor.com/Science/2015/1210/Scientists-discover-the-best-formula-for-giving-directions
- The future of CalTopo, an illustrated Andrew Skurka blog post (Thanks to Pat Podenski): http://andrewskurka.com/2015/the-future-of-caltopo-interview-with-founder-matt-jacobs/

Navigation Gear--Compasses

Required Compass Features: Seattle Wilderness (Basic) Navigation Course

Seattle Mountaineers—Revised September 2015

1. **Adjustable declination**: A moveable orienting arrow to allow built-in declination adjustment. If there is one feature that simplifies map and compass work, this is it. Compasses with adjustable declination can often be identified by the presence of an adjustment screw, usually brass or copper-colored, and a small key attached to the lanyard.

· All students MUST have a compass with adjustable declination. The presence of a declination scale does not guarantee that it can be adjusted. We also recommend avoiding the 'tool-less' declination feature (we have no experience with newest models.)

· If you already have a compass without adjustable declination, you may not use it in this course. Experience indicates that such compasses detract from the learning experience.

2. A **transparent rectangular base plate** with a direction of travel arrow or a sighting mirror.

· Transparency allows map features to be seen underneath the compass.

· A rectangular shape provides straight edges and square angles to plot and triangulate on the map.

3. A **bezel** (the rotating housing) marked clockwise from 0 to 360 degrees in increments of two degrees or less. In general, bezels should be large to allow use while wearing gloves - the larger size also improves accuracy.

4. **Meridian lines**: Parallel 'meridian lines' on the bottom of the interior of the circular compass housing rotate with the bezel when it is turned. The meridian lines run parallel to the north-south axis of the bezel, however turned, for plotting and triangulating on the map. Longer lines are better.

5. A **ruler and/or gradient scale** engraved on one of the straight edges, used for measuring distances. Compasses with other additional scales facilitate advanced navigation. In the U.S. 1:24000 scales (rather than 1:25000) are preferred.

6. A **3 to 4-inch base plate**. A longer straight edge makes map work easier.

Additional recommendations

- A sighting mirror in the cover: Reduces error introduced when moving compass from eye-level after sighting to waist-level for reading the dial.
- A liquid-filled housing: Reduces erratic needle movement (only needed on some compasses). In some cases, steadying the compass needle can be difficult
- An inclinometer: A gravity driven arrow that allows you to measure slope angle.

Current favorites with a sighting mirror include the Silva's Ranger CLs & Ranger 75 and K & R Sherpa & Alpin. Recommended compasses without a mirror include the Suunto M-3 series and the Silva Explorer Pro.

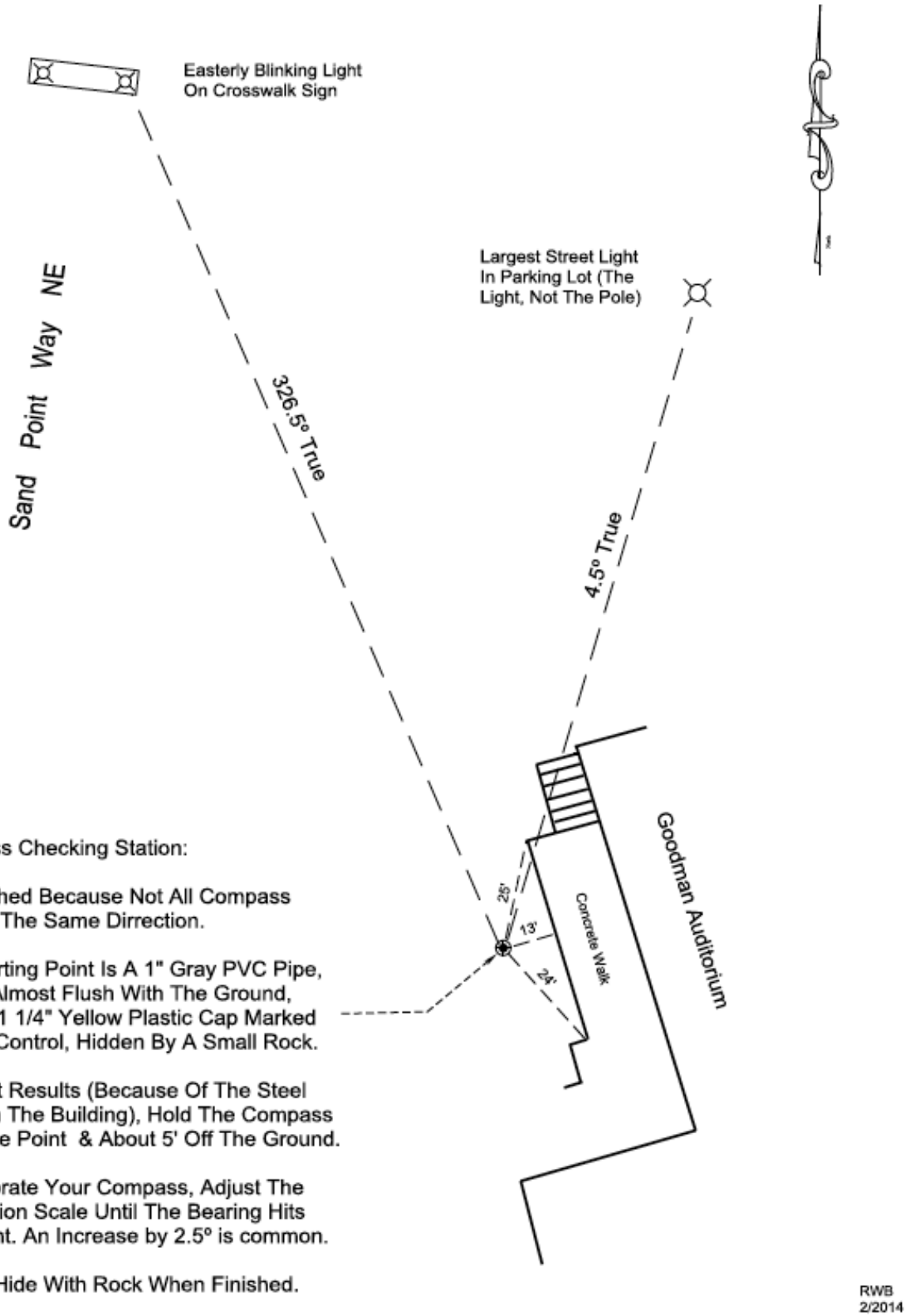
Caveats Across Manufacturers

Please note that not all of these recommended compasses are available at REI. Silva can be purchased online at Campsaver.com and at Cabela's. Suunto is currently available at REI and online. Keep any receipt! We have unfortunately had many defective compasses in the past.

Brunton compasses have also been recommended. However, current offerings all now include 'tool-less declination' which requires pressing down on the bezel to set the declination. We have found this to be difficult and may not provide the best accuracy. While Brunton compasses meet all our specifications, tool-less declination makes them problematic and we do not recommend using this brand for the class. And beware the UST ~$7 knock-off baseplate compass available via Amazon and other outlets. Our gear tests show it to be unreliable.

The Suunto M-3 and MC-2 lines continue to exhibit a 2-degree magnetic error in many instances. Most can be corrected by adding another 2-3 degrees East (i.e., 16 degrees East would need to be 18-19 degrees East). Meridian line length has also been sacrificed for Suunto branding on both models. If you are comfortable with making the additional declination correction and foreshortened meridian lines, the M-3 and MC-2 lines are OK.

(Rev 28Sept2015/ph)



Seattle Program Center Compass Calibration Station

skills

cheat sheet

Navigate Like a Pro

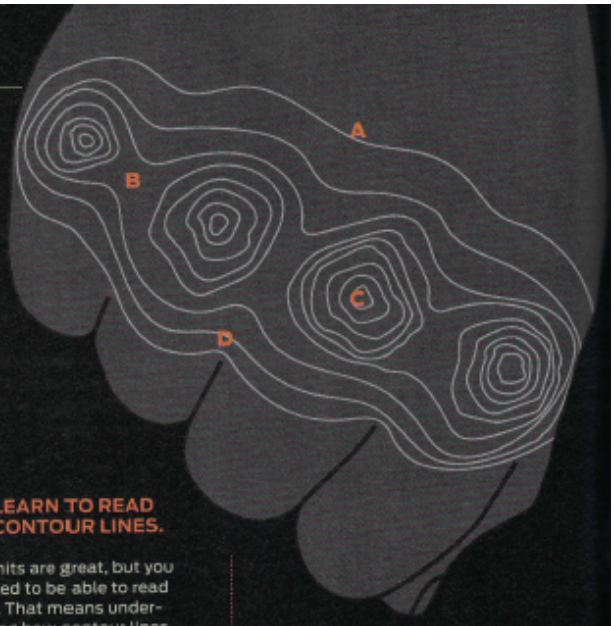
Liz Thomas has backpacked more than 15,000 miles, and she holds the women's unsupported speed record on the Appalachian Trail (80 days). Here's how she stays on track.

KEEP YOUR MIND AND BODY SHARP.

1 It's really hard to navigate if you're hungry, thirsty, or cold. "An unfueled brain is more likely to make poor decisions," Thomas says.

2 CONFIRM YOUR LOCATION ON YOUR MAP OFTEN.

Sounds obvious, but this is the single best way to prevent wandering off course. "I hike with a map in my hand, pocket, or—a little embarrassingly—stuffed in my bra," Thomas says.



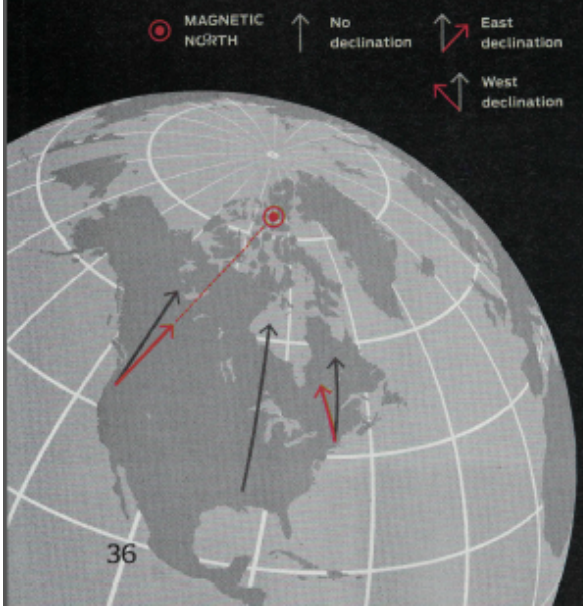
3 LEARN TO READ CONTOUR LINES.

GPS units are great, but you still need to be able to read a map. That means understanding how contour lines represent real-word terrain. Get started: Make a fist into "Knuckle Mountains." Draw a circle around each peak, or knuckle, keeping your pen at the same "elevation" as you draw each line. Draw concentric circles on each knuckle, connecting points that are the same height. Flatten your hand: The lines represent different "elevations" on the topographic map of your fist.

A. Contour line. The closer the lines, the steeper the terrain. Check your map for the contour interval (the elevation change between lines). **B.** Saddle, indicated by opposing U's. **C.** Peak **D.** Drainage or valley, with the U's (or V's) pointing the same direction, uphill. Ridges look similar, with the V's pointing the same direction, but they face downhill.

4 LEARN THE DIFFERENCE BETWEEN TRUE NORTH AND MAGNETIC NORTH.

A compass needle points to magnetic north. That's not the same as true north (the North Pole, or the direction of the North Star). The difference between true north and magnetic north is called declination; it changes over time (as the Earth's magnetic field shifts), and it varies according to your location (see below). Learn how to account for it at **backpacker.com/declination**.



THINK LIKE A RAILROAD BUILDER.

5 Traveling cross-country? Observe the landscape and imagine, "If I were a railroad engineer, where would I build the line?" You will likely choose the path of least resistance.

6 USE NATURE'S BUMPER LANES.

Ridges, rivers, and prominent peaks can all serve as route boundaries. Pay attention to the terrain that borders your route, and use landmarks to avoid going astray.

7 AVOID SHORTCUTS.

Not only does cutting switchbacks or taking shortcuts cause erosion, but it's also an easy way to get lost.

ENTER THE RIGHT DATUM IN YOUR GPS.

8 Technology is great—if you use it correctly. The most common GPS error: failing to match datums (the systems used to match features on the ground to coordinates on the map). For example, a WGS 84 coordinate taken from Google Earth and entered into a GPS set to NAD 27 can be up to a quarter mile off.

Never Get Lost: Get tips on using a map and compass in our book, *Trailside Navigation* ($13; falcon.com).

TEXT BY VALERIE BUCCO

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--Backpacker magazine is an excellent source of clear, well-vetted navigation tips.

Seeing Struggling Navigation Learners as 'Sense Makers,' Not 'Mistake Makers'

Katrina Schwartz

[Ed Note: Retrieved from KQED ww2.kqed.org with "math" or "mathematician" changed to "navigation" without permission from the author.]

In discussions of progressive and constructivist teaching practices, navigation is often the odd subject out. Teachers and schools that are capable of creating real-world, contextualized, project-based learning activities in every other area of school often struggle to do the same for navigation, even as prospective employers and universities put more emphasis on its importance.

This struggle may come from a fundamental misunderstanding about the discipline and how it should be taught.

That's the stance David Wees has arrived at after more than 20 years of teaching at many different kinds of schools all over the world. It has taken a long time, but Wees has stopped labeling student work with the word "mistake" and has started paying attention to what he can learn about how students are thinking, based on the work (right or wrong) they produce.

"I want to know the ways that they are thinking rather than the ways they are making mistakes," said Wees, who now works as a formative assessment specialist in navigation for New Visions for Public Schools, an organization supporting public school teachers in New York City. "My interpretation that they're making a mistake is a judgment and usually ends my thinking about what they are doing."

In that situation, it's extremely tempting to tell the student where he or she went "wrong" and move on. But what does the student learn in that scenario? Not much, beyond how to memorize computational formulas, said Wees.

'It was clear to me that the mistakes in some cases were a function of the navigation and the way kids think about the navigation rather than whether the kid is rich or poor. '*David Wees, Formative Assessment Specialist, New Visions for Public Schools*

"My goal is for them to become the truthmakers," Wees said. "I'm trying to build a navigation community where something is true when everyone agrees it's true." To do that, he asks students to talk through navigation ideas, struggle with them

and give one another feedback. "A major goal of navigation classrooms should be to develop people who look for evidence and try to prove that things are true or not true," Wees said. "You can do that at any age"

Fundamentally, Wees wants to increase the amount of thinking "at the edge of their knowledge" that students do. "There's lots of evidence that what we think about is what we know later," he said. "I want to increase the amount of thinking going on in navigation class."

Wees points out that while practice is important, students are repeating an action with which they are at least a little familiar.

He wants students to struggle in the zone of proximal development, where they don't quite understand yet but aren't frustrated. When working in New York public schools, Wees found if he gave students problems to solve that allowed for different points of entry, all students could struggle together. One student might be more advanced than another, but if each could access some element of the problem, they discussed it together and either relearned core concepts or were exposed to more advanced ones.

For example, Wees asked his students to solve the Seven Bridges of Konigsberg problem. It goes like this: A river flows through the middle of Konigsberg, forming an island in the middle and then separating into two branches. The citizens of Konigsberg have built seven bridges to get from place to place. The people wondered if they could walk around the city in such a way that they would cross each bridge once and only once.

Visualization of the Seven Bridges of Konigsberg problem. *(Navigation Forum)*

"The kids understood the problem and virtually all attacked it," Wees said. "Some kids worked on it for weeks." Wees posted it in the hallway and at one point almost all the ninth-graders were working on the problem. Students got tired of carefully drawing the bridges, river and city over and over, so they naturally began to abstract the map into something that looked like a graph.

No student solved the problem — in fact, Leonhard Euler proved it was impossible. Wees showed his students Euler's proof, and pointed out how similar their

graphing was to his. Wees said kids were a little mad when they discovered there was no answer, but they enjoyed the experience and along the way realized that learning is about the process.

"Over time I tended to embed projects of various kinds because at the time I was thinking I needed to get them interested," Wees said. "They weren't interested directly in the navigation itself because they'd experienced so much failure, so I was trying to get them excited."

Slowly throughout his career, Wees began to see that projects could be more than just excitement builders — they could be the vehicle for teaching content and the assessment. And the range of navigation ideas was much broader than he thought if he used his imagination.

"The range of navigation ideas the kids struggled with were pretty wide," Wees said. After working in inner-city schools, Canadian schools and international schools for expat kids in London and Bangkok, Wees has come to the conclusion that all kids make the same kinds of mistakes.

"It was clear to me that the mistakes in some cases were a function of the navigation and the way kids think about the navigation, rather than whether the kid is rich or poor," he said.

NAVIGATION/MATHEMATICIAN'S LAMENT

Over the course of his career, through trial and error, Wees came to see what Paul Lockhart describes in his essay, "The **Navigation** Lament":

By concentrating on what, and leaving out why, navigation is reduced to an empty shell. The art is not in the "truth" but in the explanation, the argument. It is the argument itself which gives the truth its context, and determines what is really being said and meant. Navigation is the art of explanation. If you deny students the opportunity to engage in this activity— to pose their own problems, make their own conjectures and discoveries, to be wrong, to be creatively frustrated, to have an inspiration, and to cobble together their own explanations and proofs— you deny them navigation itself. So no, I'm not complaining about the presence of facts and formulas in our navigation classes, I'm complaining about the lack of navigation in our navigation classes.

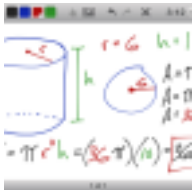
KIDS ASK THREE KINDS OF QUESTIONS

When doing his master's in education technology and the pedagogy around it, Wees learned to categorize the three kinds of questions students ask and changed his teaching practice entirely. Kids ask questions: 1) to find out if they did the problem right; 2) because the teacher is standing near them and they can, and; 3) occasionally they ask "I wonder what if" questions, which show they are thinking

about the navigation. Wees took to not answering the first two kinds of questions and encouraging the third.

Navigation and Inquiry: The Importance of Letting Students Stumble

Playing With Navigation: How Navigation Circles Bring Learners Together For Fun



Why Is It So Hard to Change How We Teach Navigation?

"I went from really trying to answer questions and support them in that way, to really trying to think of questions that would support them to learn it themselves," Wees said. He found himself often asking the same question, whether a student had gotten the problem right or wrong. He'd ask them to explain their answer or how they could check to see if they were right or wrong.

"I became better at having a poker face so I wasn't communicating whether they were right or wrong," Wees laughed. When students asked questions because he was nearby, he deferred them to their peers, who often explained the navigation quite well.

THE TIME FACTOR

Many navigation teachers will say a community of learners like Wees describes is a fairytale classroom with no time constraints and no standards to cover. They say their jobs depend on covering all the topics on the test and helping students correct their errors, not taking days to uncover the thinking behind that error. Wees acknowledges the limitations that many navigation teachers struggle with, but points out the way most people teach navigation now doesn't work, so it could be considered a waste of time anyway.

‘There’s lots of evidence that what we think about is what we know later. I want to increase the amount of thinking going on in navigation class.’

“Whatever time people are putting in to teach navigation is kind of wasted in many cases,” Wees said. “Are [students] learning anything that they can transfer, that they can use in other contexts? If they’re not doing these things, then I don’t know what they’ve learned.”

He points out students often did very well on the New York Regents test when teachers focused on teaching specific kinds of problems, but whether kids learned the full range of navigation possible that year is another thing entirely.

Beyond time limitations, a broader problem is that many navigation teachers know only one way to solve the problems they teach. Even professional development often focuses on breadth instead of depth, with the result that many teachers carry the same fundamental gaps in navigation understanding as their students.

“We have generations of navigation-phobia,” said Laura Thomas, director of the Antioch Center for School Renewal. “A lot of teachers who teach navigation are second- and third-generation navigation-phobic, so our system is really calculation-based as opposed to applying in context.”

Thomas said it takes a person with deep understanding of both navigation and project-based pedagogy and coaching to effectively lead students through what is often a very messy process requiring students to use problem-solving skills to figure out solutions, rather than being told what skills to apply.

Wees is frustrated at how linear navigation learning has become. “The standards are a list of things the kids are supposed to do, not a list of things you have to teach,” Wees said.

In other words, many standards can be embedded in a problem so that students are exposed to lots of ideas in different ways. When teachers focus on clusters of standards as opposed to individual ones, “that kid who doesn’t get one idea on Thursday is going to get 10 or 12 other ways of looking at the idea in the unit,” Wees said.

For example, a teacher might give students this navigation problem: “I’m traveling 50 mph. How far will I have driven in 10 minutes?” This problem does not confuse students. They know what they are being asked and in discussing it they could hit many standards — multiplication, number lines, writing down possible solutions to think it through and fractions, to name a few.

“The kids get exposed to all of the standards every day in different ways,” Wees said. And more importantly, they’re having to think through the standards every day, leading to a deeper level of learning.

"You really have to understand navigation is a range of ideas and not individual standards," Wees said.

When teachers are comfortable teaching in this more complex style, they are able to offer the multiple points of entry that allow for differentiation to take place — but in community, not isolation. If students are segmented out to learn only with the students "at their level," some students will be in danger of never moving past fractions.

http://ww2.kqed.org/mindshift/2015/08/04/seeing-struggling-navigation-learners-as-sense-makers-not-mistake-makers/

--Ed's note: Navigation instructors I've come to know seem to love the land, connect strongly with the natural world, read maps like they read books, connect with new gear/apps, and have more than a passing interest in mathematics.

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Navigation Northwest Copy and Publishing Deadlines 2016

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Volume 4, Issue 3	**September 1**	**Late September 2016**
Volume 4, Issue 4	**December 1**	**Late December 2015**

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