

Lab Field Trip program for K-12 Students, Hosted by University Researchers: Description for EarthRef.org Digital Archive (ERDA)

Author: Katharine W. Huntington, University of Washington

Developed in collaboration with high school teachers and educators from Washington State, and University of Washington students, colleagues and laboratory members. Supported by U.S. National Science Foundation grants EAR-1252064, 1156134, and 0955309 to Huntington, and NASA grant NNX16AB86A to the University of Washington.

I. Introduction

University researchers host K-12 students for a hands-on laboratory field trip that is integrated with science class curriculum and includes mentorship and/or broadening diversity in science activities. Students learn about research methods through hands-on activity stations, and researchers practice explaining their science to a broad audience. Visits to the university campus and lab(s) include small group mentorship question-and-answer sessions led by undergraduate science majors.

The “lab field trip” model is easily adapted to different laboratory types, research topics, and middle/high school student demographics. Example logistical information, lab activity descriptions and materials are presented for ninth-grade general science students working with geologists and biologists studying paleoclimate, including planning accommodations for students with disabilities and English language learners. A climate monitoring activity station using NASA satellite data, and a simple lab tour worksheet (for seismology and isotope labs) is also included. Example mentorship question-and-answer session materials are tailored to undergraduate volunteers from diverse backgrounds mentoring economically disadvantaged minority high school students regarding higher education and STEM majors.

II. Goals of the Lab Field Trip Program

The goals of the Lab Field Trip program are to support middle and high school science curriculum, science literacy, college readiness and diversity in STEM fields. Successful Lab Field Trip programs build step-by-step to go beyond the “lab tour” model through sustainable partnerships between university researchers and K-12 science teachers. Partnerships enable principal investigators (PIs), their research groups and teachers to develop learning goals for students that align with national standards and can be achieved via classroom assignments and activities that complement the laboratory field trip experience. Successful partnerships may:

- Build on prior experience and teacher-researcher relationships developed through simple “lab tours” with small cohorts of students or other outreach activities (e.g., **Teacher Externship program** described elsewhere in this database).
- Benefit teachers by increasing student engagement and mastery of Common Core learning objectives.
- Involve and benefit university students by providing mentorship and teaching opportunities.
- Benefit high school students via lasting curriculum enhancements and mentorship.
- Benefit PIs by providing an efficient means to enhance the impact of their research, satisfy funding agency “Broader Impacts” requirements, and hone their own science communication and teaching skills.
- Require limited PI time to manage, sustain and adapt once established.

III. Example Lab Field Trip Program Development Strategy

Long-term partnerships between teachers and researchers can be efficient and effective means to develop educational outreach and broadening participation activities and support student learning. A successful example of a Lab Field Trip program developed at the University of Washington includes classroom assignments and labs, university lab demonstrations and hands-on activity stations described in a comprehensive student workbook, mentorship session guidelines, and pre- and post-trip assessments designed to accommodate 75-85th graders in a one-day field trip, held one to two times annually. An integrated program of this scope could be developed by the PI and research group with manageable time investment over three years. An example timeline and overview of activities is provided below:

Year 1: Conduct simple lab tours and outreach activities to develop experience, test ideas for activities, and develop relationships between university researchers and K-12 teachers. Ad hoc tours require little preparation and time commitment on the part of the researchers. Activities are commonly initiated by outside groups rather than the research group, and logistics and transportation are handled by visiting groups. *For example*, a lab may host multiple 30-60 minute lab tours for groups of 8-30 people, ranging from elementary school age children, to high school science students, to community members invited to campus by the university development team. Graduate or undergraduate student members of the research group may volunteer to judge a science fair or do a classroom demonstration. Whatever activities the research group engages in, materials and contact information for volunteers and teachers should be archived electronically in a central online repository to facilitate collaboration (e.g., GoogleDrive or Dropbox).

Year 2: Partner with a teacher to plan Lab Field Trip activity stations and a complementary classroom activity. Conduct simple lab tours and outreach activities to practice the activity stations. Optional: conduct student pre-assessments, and/or implement classroom activity. The teacher should be familiar with the research group and/or lab activities (e.g., because she or he has participated in a simple lab tour with students), and should have ultimate responsibility for identifying how the lab and

research program relate to the K-12 course and Common Core requirements. Beginning with the student learning and mentorship goals, the teacher and research group members work together to plan activity stations to accommodate the number of students and volunteers that will participate in the Lab Field Trip, and to develop or modify one classroom activity (e.g., a lecture, lab, homework assignment, project, reading and writing assignment) to help prepare students for the Lab Field Trip. Labor can be divided among research group members, with oversight from the PI and input from the teacher. The teacher can then draft a basic Lab Field Trip handout for students, with content support from research group members. An accompanying Lab Field Trip handout for activity station leaders should also be drafted. A pre-assessment may include content questions and questions focused on the mentorship goals for students to provide control results to evaluate the impact of the Lab Field Trip program. *For example*, the **Teacher Externship program** described elsewhere in this database is an effective and efficient model for developing content. Example content materials are provided in Sections V and VI. Archive materials and participant contact information electronically in the central online repository.

Year 3: Implement classroom activity, and hold the first Lab Field Trip, pre- and post-assessments. The activities have been developed and volunteers have gained experience leading them over the prior two years, so the focus of the first Lab Field Trip is on logistics (e.g., organizing transportation, materials, handouts, permissions, schedules, room reservations, volunteers, accommodations for students with disabilities and English language learners, etc.; see example timeline and logistical materials in Section IV). Discuss mentorship question-and-answer (Q&A) session goals (e.g., Q&A aimed to mentor minority students from an economically challenged community could be led by undergraduate science majors from diverse backgrounds and focus on why they chose to pursue higher education, the challenges they had to overcome to attend college, and opportunities for work-study jobs in research labs). Pre- and post-Lab Field Trip assessment is important to arrange in advance, for both the mentorship and science concepts, ideally comparing participants with a control group of students that did not participate in the trip. Finalize the student and activity session leader versions of the Lab Field Trip handout before the trip, and revise after. Archive materials, volunteer contact information, and logistical information and timeline electronically in the central online repository.

Year n: Implement classroom activity, and conduct Lab Field Trip, pre- and post-assessments following templates from the previous year. A second classroom activity may be developed, a Lab Field Trip activity station may be modified or exchanged for a different activity station. New undergraduate volunteers may be recruited for the Q&A mentorship sessions. The key is to maintain complete and up-to-date records of the timeline and information for logistics, handouts, and lesson plans for each activity station in the central online repository.

This type of strategy was used to develop the Lab Field Trip program at the University of Washington IsoLab. The plan was incorporated into a research proposal by the PI, which was funded by NSF, providing graduate student RA support to organize the activity as

well as logistical support including bus rental to transport the visitors to campus, and substitute teacher pay to enable teachers to attend.

The Lab Field trip Program at the University of Washington IsoLab is successful and sustainable, supporting 75-150 high school students per year (most of whom are from underrepresented groups, including disability and English language learner accommodations, and are eligible for free or reduced-price lunch programs). Assessments show significant learning gains for students taking the same course who participated in the Lab Field Trip compared to those who did not. Qualitative responses from students demonstrated improved perceptions about higher education and STEM fields. Qualitative responses from undergraduate and graduate student volunteers indicated that the experience was rewarding, and that research group members developed science communication skills they felt enabled them to more effectively share research findings with broad audiences.

IV. Example Lab Field Trip Logistical Materials

A general timeline of activities for an April Lab Field Trip is provided, including an example schedule matrix for a 4-hour field trip for 75 students plus teachers and chaperones. This timeline is appropriate for “*Year n*” described in Section III, and assumes the PI, at least one teacher, and at least one responsible graduate or undergraduate research group member (“lead research group contact”) have participated in a previous Lab Field Trip. Examples discuss considerations for planning accommodations for students with disabilities and English language learners.

Timeline:

January – PI sends email confirming participation with teacher(s) and lead research group contacts(s), who select possible Lab Field Trip dates for April. PI checks in with teacher about funding for visitor transportation to campus and for substitute teacher pay. For example, funds may be provided by a federal or other grant to the PI or teacher; by the university or department; by another outreach program on campus; by the K-12 school, district or PTA, etc.

February – Teacher completes paperwork with school district requesting approval for first choice Lab Field Trip dates and times (followed by second and third choice if district does not approve). PI provides letter of support if required. PI confirms research group member volunteers for the final selected date and time. Lead research group contact reserves rooms on campus and instrument/lab time as needed. Lead research group contact and/or PI sends email request (modified from email and contacts on file from the previous year) for leaders for each activity station.

March – Lead research group contact and/or PI confirm leaders for each activity station. Teacher arranges transportation, chaperones and permission slips, including photo release

permission to use photos of minors participating in the event. PI sends first request for undergraduate volunteers to lead the mentorship Q&A sessions, lead campus tours (if desired), and facilitate logistics (e.g., shepherd visitor groups from station to station). Advertise undergraduate volunteer opportunity broadly, noting that volunteering a great resume builder for students. Confirm 1.5 times the required number of undergraduate volunteers to avoid problems with last-minute cancellations. PI informs departmental and/or other relevant colleagues and administrators of the Lab Field Trip date, time, room locations and approximate number of participants.

Three weeks before the Lab Field Trip – Teacher may begin to incorporate materials into the K-12 curriculum, plans to conduct pre-trip assessments, and manages permission slips, chaperone recruiting if necessary, and transportation logistics. Lead research group contact confirms rooms, dates and times with all participants, and posts matrix of times, volunteers, locations, student groups, chaperones etc. online, supervised by the PI (see example below). Include names and cell phone numbers of all volunteers and teachers in matrix. Hold orientation meeting to distribute lesson plans to activity station leaders, who are responsible for assembling all materials. Update student handout packet with the schedule and room locations for this year.

Discuss special needs accommodations if appropriate. For example, plan access routes to the labs and locations for participants on crutches or in a wheelchair and recruit additional undergraduate volunteers if needed to assist special needs participants who require additional time/different routes around campus; recruit chaperones able to translate for English language learners. To address such needs, a field trip for 75 students required 9 adult chaperones: two teachers, four parents/alumni/AmeriCorps volunteers, one para educator (staff to support student in wheelchair with limited mobility), and two English language learner (ELL) support staff.

One to two weeks before the mid-April Lab Field Trip – Remind undergraduate volunteers of their commitment. Manage last-minute schedule/logistics adjustments. Confirm precise meeting location and time for visitor arrival.

Week of the Lab Field Trip – Hold orientation meeting for undergraduate volunteers to discuss mentorship Q&A plan and logistical assistance duties. Confirm station leaders have all necessary materials. Tidy lab spaces. Print out handout packets for students. PI reminds departmental and/or other relevant colleagues and administrators of the Lab Field Trip date, time, room locations and approximate number of participants.

Day of the Lab Field Trip – Designate a single go-to person (e.g., the PI) for all participants to contact for logistics problems. Designate a volunteer to photograph the event, and give that person(s) the schedule with times and room numbers. Confirm special needs accommodations are in place if necessary (e.g., for disabilities, English language learners).

Follow up – Thank all volunteers. Thank teachers and school office staff. Publicize the event and volunteer contributions. Conduct post-assessments. Update field trip materials and records. Pay bus rental and substitute teacher invoices, if relevant.

Schedule Matrix:

This example schedule matrix was developed by Kelly Egaas and David Ruppert from Highline School District (WA) together with Katharine Huntington and members of her research group and IsoLab at the University of Washington, primarily Andrew Schauer, Julia Kelson and Landon Burgener.

In practice, the matrix is used in the format of a sharable Google Spreadsheet to facilitate collaboration and updates. Here, the matrix is archived in Excel spreadsheet format.

Example handout with itinerary, for students and chaperones:

Handout developed by teacher Kelly Egaas, Highline School District.

Itinerary-

- 8:00- students leave their 1st period class and meet in cafeteria
- 8:15- load the bus and leave parking lot by 8:30
- 8:55- arrive at Johnson Hall, get organized into groups
- 9:00- Session 1- Demo from Geology prof and talk with undergrads
- 10:00- Session 2- Data Sample Collection and prep
- 11:00- Session 3- Analysis- visit lab to see how samples are analyzed
- 12:00- lunch
- 12:30-1:25pm- students will break into their small chaperone groups to self-tour campus
- 1:30- Students will meet to load the buses to head home.
- 1:40- bus pulls out of UW parking lot
- 2:00- students return to school in time to take their normal transportation home.

Eating Opportunities- students were told to bring a snack and to either bring a lunch or bring money to purchase their lunch at the student union building (HUB). As a group chaperones and their students can decide to eat in the food court or sit somewhere (like outside) to eat lunch.

Checklist for day of fieldtrip

- ☐ Good walking shoes
- ☐ Clothing appropriate for the weather
- ☐ Jacket
- ☐ Sack lunch or \$10 for lunch
- ☐ Pen or pencil
- ☐ Composition book
- ☐ Camera (optional)

UW Campus Rules

- ◆ Keep the volume of your voice low when near classrooms.
- ◆ Take advantage of recycling and waste containers throughout the campus.
- ◆ Stay with adult chaperones at all times.

V. Example Activity Station Descriptions

This section provides a summary of example activity station activities, which were developed but the major contributors listed below each station description, in collaboration with the PI (Huntington). In this example suite of activity stations, students are divided into nine groups of approximately 8 students and 1 adult chaperone. Each group rotates through eight stations, seven of which present different aspects of paleoclimate research, while the final station focuses on life as a college student at the university (i.e., the Q&A mentoring session). This list of stations accompanies the 2016 student handouts described in Section VI, and is compatible with the example schedule matrix provided in Section IV. Complete activity station lesson plans will be archived separately.

Station 1: *Pollen Analysis*

In this station, students learn how paleoclimatologists collect, prepare, and analyze ancient pollen samples in order to reconstruct paleoclimate and paleoenvironmental conditions. They identify pollen samples under a microscope to test a hypothesis about local environments of Washington State in the past. (Major content contributors: Stephanie Zaborac)

Station 2: *Remote Sensing and Climate*

This station highlights how space-borne remote sensing instruments can generate valuable climate data. The station reviews the basic concepts behind collecting remote sensing data, gives students the opportunity to use an infrared camera, and discusses how satellite data can be related to physical samples (e.g., dust in sediment cores, ice cores). Students learn how our understanding of modern climate improves our ability to reconstruct past climate states, which in turn helps us predict the consequences of future climate change. (Major contributors: Landon Burgener and Julia Kelson)

Station 3: *Ice Cores*

This station gives students the chance to see real ice cores collected from Antarctica and learn how scientists analyze various aspects of ice cores to reconstruct past climate change. Students walk through an ice-core freezer and get to help a researcher cut a “practice” ice core made from frozen tap water using a special ice saw. (Major contributors: Andrew Schauer and Kyle Samek)

Station 4: *Sediment Cores and Carbonates*

This station introduces students to paleoclimate proxies derived from two geologic archives: lake sediment cores and carbonate minerals. Students learn how sediment cores are collected and what types of information can be recovered from such samples, including pollen like they analyze in Station 1 and in their classroom lab activity. Additionally, they learn about the types of natural carbonate minerals that occur in different modern

environments and get preserved in the geologic record, and how those samples are collected and then prepared for isotopic analysis. Students use dremel drills to collect soil carbonate samples from the bottom of rocks, or marine carbonate samples from shells. (Major content contributors: Spruce Shoenemann, Landon Burgener and Julia Kelson)

Stations 5 and 6: *Acid Reaction and Purifying Samples*

These stations introduce students to the Isolab clumped isotope vacuum prep line, where they learn how carbonate samples are reacted with acid to release CO₂, which is then purified and collected for analysis via transfer through the vacuum line. The students participate in two small demonstrations. First, they see how baking soda and vinegar react to form a gas, and learn that this process is analogous to the acid-carbonate reaction taking place in the vacuum line. Students are asked a series of questions and demonstrations with glassware and balloons to figure out how to capture the sample CO₂, without contaminating it with air. Second, students use thermometers to learn how different substances (e.g., water vapor and CO₂ gas) freeze at different temperatures. They experience using liquid nitrogen and balloons how the prep line can be cooled to various temperatures in order to separate the sample CO₂ gas from other impurities. (Major content contributors: Katharine Huntington, Andrew Schauer and Kyle Samek)

Station 7: *Isotope Measurement*

In this station, students learn about isotope mass spectrometry, how purified CO₂ samples are measured on Isolab's various spectrometers, and what climate information scientists can reconstruct from isotopic records. In a short demonstration, students collect samples of their own breath, which is then analyzed on a mass spectrometer. The students use the carbon isotope data from their own breath samples to determine the relative amount of corn in their diet. (Major contributors: Andrew Schauer)

Station 8: *Volcano Demonstration and Student Panel*

This station is divided into two parts. First, students observe an exploding "cryo-volcano" demonstration and learn how volcanoes interact with and affect the Earth's climate. The second part of the station involves a Q&A session where the high school students have the opportunity to ask questions about applying to college and college life to a panel of undergraduate science major volunteers. (Major contributors: Brittany Brand and Michael Harrel)

VI. Example Lab Field Trip Program Educational Materials

The example Lab Field Trip educational materials compiled here were developed by the individual contributors listed for each item.

Simple Lab Tour student question worksheet. Example worksheet for a simple lab field trip for Seismology Lab, Stable Isotope Lab, Library tour, and mentorship Q&A with undergraduates; editable DOC. Diane Nielsen and Patty Weston, Mercer Island School District, Washington, in collaboration with Katharine Huntington and other University of Washington faculty and staff.

Lab Field Trip student packet. Complete 2014 example PDF. – Kelly Egaas, David Ruppert, Highline School District; Katharine Huntington and members of the Department of Earth and Space Sciences, IsoLab, Quaternary Research Center and Biology Department at the University of Washington.

Lab Field Trip student packet and pre-trip reading assignment (versions 1, 2, 3). Modified after the 2014 student packet example, and compatible with example activity station descriptions from Section V; editable DOC, with three versions of the questions to avoid cheating in large classes; includes pre-field trip reading assignment. – Chandra Vostral, Bothell Tutoring.

Classroom activity: pollen and paleoclimate lab – Kelly Egaas, Global Connections High School, Highline School District, Washington.

Classroom activity: ice core lab – UW in the High School lab for “Climate and Climate Change” course ATMS 211, developed independently of the Lab Field Trip program by University of Washington graduate student Ashley Maloney of the Department of Oceanography and Program on Climate Change.