GETSI Field 2018 Annual Report - UNAVCO

Collaborative Research: A Field-Based Curriculum for Quantifying Deformation of the Earth's Surface with Lasers, GPS and Cameras

Project Period: 06/01/2016-05/31/2019

Reporting Period: 06/01/2017-05/31/2018

Principal Investigators: Donna Charlevoix (PI), Beth Pratt-Sitaula (Co-PI)

Sponsor: NSF DUE-IUSE

Award ID: 1612248

Collaborators: Bruce Douglas (Indiana University), Benjamin Crosby (Idaho State University)

Geodesy field education short course group photo. Short course on TLS, SfM, and GPS methods was held August 2017 at the UNAVCO office and field sites in the greater Boulder area. Twenty-five field instructors were participants.

Accomplishments

What are the major goals of the project?

The primary program goal is to improve students' Earth science understanding and workforce-ready capabilities through field education experiences that incorporate geodetic technologies and applications. Resources (inputs) for this project include NSF funding, the UNAVCO GAGE Facility, faculty collaborators, SERC (Science Education Resource Center), NAGT (National Association of Geoscience Teachers), and the geodesy community. The three goals are student-focused either directly or toward improving instruction through faculty development.

Goal 1. Build student understanding of geodetic instrumentation, techniques, and applications

> Objective 1.1: Increase student understanding of geodetic instrumentation, methods, and applications, specifically Terrestrial Laser Scanning (TLS), Structure from Motion (SfM), and Static and Real-time Kinematic (RTK) Global Positioning Systems (GPS)
>
> Objective 1.2: Increase student ability to collect, analyze, manipulate and interpret geodetic field data
>
> Objective 1.3: Increase student knowledge of the array of scientific challenges and problems that can be studied using geodetic tools

Goal 2. Increase faculty efficacy in teaching geodetic techniques in geology field courses

> Objective 2.1: Develop robust learning modules for field or classroom use that are flexible enough for instructors to integrate into field camps and classes
>
> Objective 2.2: Increase faculty knowledge of best practices for instruction in field courses

Goal 3. Obtain baseline data from faculty to better understand successes and challenges of implementing pre-developed curricular materials in field education experience

> Objective 3.1: Document faculty experience in field instruction, motivation for incorporating geodetic technologies, and working knowledge of best pedagogical practices

Project activities will result in (outputs): two modules for incorporating geodetic technologies in field education, multi-day professional development workshops for geoscience faculty, one-day short courses for faculty training, baseline data on how faculty adopt curricular materials into their field instruction, and student data contributed to the GLE (Geosciences Literacy Exam) national database. The student and faculty outcomes are articulated in the project objectives.

What was accomplished under these goals?

Major Activities

During this second year of the grant we have:

- Completed and published the second of two teaching modules – *High Precision Positioning with Static and Kinematic GPS/GNSS* (https://serc.carleton.edu/getsi/teaching_materials/high-precision/index.html)
- Conducted a 2.5-day in-person professional development short course for 25 field instructors to support their understanding of the geodetic methods and implementation into their courses (elements of both *Analyzing High Resolution* and *High Precision Positioning* modules) – "Using high resolution topography, UAVs, and GPS in undergraduate field education" (https://www.unavco.org/education/professional-development/short-courses/2017/field-education/field-education.html). Two of the presenters for this course were actually participants in the 2016 course who had particular interest in field geodesy methods and had their own work to share with new participants. One of them, Yonathan Admassu (James Madison University) even went on to author a new unit for the *Analyzing High Resolution Topography* module mentioned below.
- The *Analyzing High Resolution Topography* module was included in two UNAVCO-sponsored 2017 GSA short courses related to TLS and SfM. More than 50 participants were at these two courses. The short course emphases were on the technical aspects of the methods, and the educational module was also covered.
- Sessions related to field education geodetic methods were proposed and executed by participants in the 2016 Geodesy Field Education short course at both GSA and AGU annual meetings in 2017.
    - GSA: T123. Pedagogical Applications of Point Cloud Collection and Manipulation
    - AGU: Field Geodesy in Undergraduate Education: Using Photogrammetry, Lidar, Sonar, and GPS to Promote Spatial Learning
- Led a webinar on the field education modules in collaboration with SERC's InTeGrate Project—"Integrating GPS, SfM, and TLS into Geoscience Field Courses" (https://serc.carleton.edu/integrate/workshops/webinars/2017_2018/field_geodesy/index.html)
- Completed the writing of an additional unit for *Analyzing High Resolution* module that introduces engineering geology--"Unit 2.1: Geodetic survey of an outcrop for road cut design"
- Recruited for and filled a third short course that will be held in August 2018--"Using kinematic and static GPS in undergraduate field courses" (https://www.unavco.org/education/professional-development/short-courses/2018/field-education/field-education.html). Note: the original proposal only included two professional development short courses but through collaboration with UNAVCO and support from Septentrio (GPS manufacturer) we are able to do this third course.

Specific Objectives

We concur with the assessment by the Science Education Resource Center external evaluator (see SERC report in Appendix) that this project has made strong progress on Goals 1 and 2 but that more data is needed before accomplishment of Goal 3 can be properly evaluated. Goal 3 depends on collection of feedback from modules users, which

has only just begun but will continue to increase as the materials have more users.

Opportunities for training and professional development?

A key component of this project is professional development for geoscience field instructors to better implement the prepared modules. As such, in this grant year we held one extended short course on project topics, collaborated in shorter events, and have scheduled another extended short course (more details above). Overall participant satisfaction has been very high as shown in the report by the Science Education Resource Center external evaluator (see SERC report in Appendix). Overall, participants were highly satisfied with the short course experience and showed great gains in confidence about teaching field geodesy methods.

One MS Geology graduate student, Ian Lauer from Idaho State University, was an active contributor to this project. He participated in the design and implementation of the 2017 short course and helped author materials for activities within the *High Precision Positioning* module. Ian served as a UNAVCO student intern in the summer of 2017, interacting with numerous other undergraduate and graduate students, as well as UNAVCO staff.

How have results been disseminated to communities of interest?

Results of this project so far include the teaching modules and the professional development short courses and webinar. Both modules were published online as part of the GEodesy Tools for Societal Issues (GETSI; http://serc.carleton.edu/getsi) Field Collection, which is hosted by the very well known SERC website (5 million visitors per year). The short courses are another way to disseminate knowledge of the teaching modules. Project PIs have presented at AGU and GSA. In addition, we use available avenues for news, listservs, and social media through UNAVCO and other partner organizations such as NAGT and AGU.

Plan for next reporting period?

During the next reporting period

- The module *High Precision Positioning with GPS/GNSS* will be further tested and slightly revised based on feedback from non-author pilot testers (ex. a faculty member from Western Washington University, who participated in the 2017 short course, is currently using the module in a course and will report back shortly). Additional prepared datasets and existing benchmark sets will be added to the module.
- We will conduct another 2.5-day short course and possibly include the field modules in other short courses run by UNAVCO and/or the larger GETSI project. Originally we only proposed doing two short courses total as part of this project, but with additional funds from UNAVCO and the GPS company Septentrio, we have been able to do three ~2.5-day short courses total.
- We will accelerate seeking feedback from module users, to obtain more baseline data on how field instructors use these teaching materials (Project Goal 3).
- We will carry out the analysis necessary to underpin a peer-reviewed publication about the project findings.

Products

Conference Papers and Presentations

Title: Teaching Resources and Instructor Professional Development for Integrating Laser Scanning, Structure from Motion, and GPS Surveying into Undergraduate Field Courses
Conference: American Geophysical Union Annual Meeting 2017
Authors: Donna Charlevoix, Beth Pratt-Sitaula, Bruce Douglas, Benjamin Crosby, Christopher Crosby, Ian Lauer, Katherine Shervais

Websites

GETSI Project Site: http://serc.carleton.edu/getsi/index.html
This is the GETSI project website. It gives background information on the project and is the primary publication site of the teaching modules when they are complete. Development workspaces allow for internal project notes and draft module text. The modules from this IUSE award are published alongside the classroom modules but are listed as the GETSI Field Collection.

Participants

Individuals

Donna Charlevoix UNAVCO Co-PI 0 Months
As the Director of UNAVCO's Education and Community Engagement, Charlevoix is responsible for coordination with the science community and the successful accomplishment of the work. Her salary is covered through the NSF GAGE Facility Cooperative Agreement.

Beth Pratt-Sitaula UNAVCO Co-PI 2 Months
A UNAVCO Educational Specialist, Pratt-Sitaula serves as the GETSI facilitator in charge of project logistics and communication. She coordinates between UNAVCO, the authors, technical experts, beta-testers, SERC, NAGT, and related organizations. She leads dissemination (meeting presentations, journal papers, articles, website content, webinars) and will ultimately write the geodesy curriculum developer's manual. Pratt-Sitaula's funding to work on GETSI is entirely from the GETSI grant (NSF Tues).

Christopher Crosby UNAVCO Professional 0 Months
C. Crosby served as a co-instructor on all the short courses in which project materials were presented. He also provides regular technical and structural advice for the project. His salary is covered through the NSF GAGE Facility Cooperative Agreement.

Marianne Okal UNAVCO Professional 0 Months
Okal served as short course co-instructor for the August 2017 short course. Her salary is covered through the NSF GAGE Facility Cooperative Agreement.

Ian Lauer UNAVCO and ISU Student 2 Months

Lauer was a UNAVCO Summer Internship Program (USIP) intern in summer 2017. He continued work on the GPS module and supported the August 2017 short course. He also work on the project under the Idaho State University part of the grant during the remainder of the reporting period. That work is captured in the ISU report. Ian is jointed funded through the UNAVCO and ISU portions of this NSF IUSE award.

Ellen Iverson SERC Professional 0 month
Iverson is the lead assessment consultant and external evaluator for the GETSI project. She is paid by SERC (Science Education Resources Center) via a service agreement with this NSF IUSE project.

Monica Bruckner SERC Professional 0 month
Bruckner is the webmaster for the GETSI project. She supports any team needs related to the SERC-hosted GETSI website and all issues related to submission of student data for assessment review. She is paid by SERC (Science Education Resources Center) via a service agreement with this NSF IUSE project.

Kristin O'Connell SERC Professional 0 months
O'Connell supports Iverson on assessment and evaluation for the GETSI project. She is paid by SERC (Science Education Resources Center) via a service agreement with this NSF IUSE project.

Organizations

Type: Academic Institution
Name: SERC (Science Education Resource Center)
Location: Northfield, MN
Contribution: Assessment and evaluation; dissemination; web hosting
Details: SERC is providing assessment design, external evaluation, project dissemination, and webhosting through a service agreement. GETSI module design and assessment are following the model of SERC's InTeGrate project. Expert assessment consultants are reviewing modules and student data is collected using the InTeGrate collection system. SERC is also hosting the GETSI website and providing content management assistance for the site and webinars. As needed, GETSI announcements go out through SERC channels to the wider geoscience community. Ellen Iverson, SERC Director of Evaluation, and Kristin O'Connell, SERC Evaluation Specialist, are providing external evaluation of the GETSI project (see SERC report in Appendix).

Type: Other Nonprofits
Name: National Association of Geoscience Teachers (NAGT)
Location: Northfield, MN
Contribution: Collaborative Research
Details: NAGT is collaborating with GETSI Field Collection on dissemination. For example, as part of publicizing short courses, announcements went out on NAGT listservs.

Impacts

What is the impact on the principal discipline?

Geodesy encompasses an increasingly important set of geoscience methods for better understanding earth processes. Its scope has greatly increased from early applications of surveying and tectonic plate motions to include critical insights into natural hazards, climate change, and water resources. Researchers now use a variety of very valuable field geodetic methods (TLS, SfM, GPS), but the barriers to use in undergraduate field courses remain high. This project is lowering these barriers considerably by providing comprehensive teaching resources and instructor professional development for using field geodetic methods in undergraduate courses. With the development of modular curricular material, the barrier for incorporating geodetic methods into field curriculum is lowered and as a result we are increasing the number of faculty who will use these materials and thereby increasing the number of students who will learn about geodesy and geodetic methods.

What is the impact on society beyond science and technology?

As our global population continues to increase, living in ever more marginal lands with ever-increasing temperatures and decreasing water resources, our ability to mitigate effectively for natural hazards, respond to climate changes, and manage our common resources becomes ever more critical. The GETSI project and the GETSI Field Collection are framing the study of earth science through the lens of societally important questions. The aim is to increase students' (future geoscience workforce's) ability to analyze and address these challenges with tangible skills.

Changes/Problems

Actual or Anticipated problems or delays and actions or plans to resolve them

So far the project is proceeding fairly close to schedule. The publication of the second module was somewhat later than originally planned, leading to the associated short course being held in Year 3 rather than Year 2. The publication delay also means we have not yet gathered the feedback from instructor users so that activity will be carried into Year 3 as well.

Appendix – Report from External Evaluator

Year Two Evaluation Report
Prepared for GETSI Field by
Ellen Iverson, Director of Evaluation
Kristin O'Connell, Evaluation/Education Specialist
Science Education Resource Center (SERC) at Carleton College

Summary

SUMMARY

The second year of the *GETSI: Field-Based Curriculum* project focused on 1) progress developing the second module, 2) holding a second short course, and 3) running a dissemination webinar for both field modules. During this period, module progress for *High Precision Positioning with Static and Kinematic GPS/GNSS* (https://serc.carleton.edu/getsi/teaching_materials/high-precision/index.html) included one pilot test, review and revisions, and progression towards completion. The materials were made available online prior to the spring webinar covering both modules. The second short course on module 1, *Analyzing High Resolution Topography with TLS and SfM*, was positively received by participants, where 20 of 22 survey respondents indicate a willingness to be part of a pilot test. Of the three goals for the project, strong progress has been demonstrated on the first two goals with some indication that the third goal could be met with further data collection.

PROGRESS ON PROJECT GOALS

Goal 1. Build student understanding of geodetic instrumentation, techniques, and applications

- *Objective 1.1* Increase student understanding of geodetic instrumentation, methods, and applications, specifically Terrestrial Laser Scanning (TLS), Structure from Motion (SfM), and Static and Real-time Kinematic (RTK) Global Positioning Systems (GPS)
- *Objective 1.2* Increase student ability to collect, analyze, manipulate and interpret geodetic field data
- *Objective 1.3* Increase students' knowledge of the array of scientific challenges and problems that can be studied using geodetic tools

Evidence of progress for Goal 1 was reported in the 2017 annual evaluation report pertaining to the student work results from module 1 and through faculty surveys. During the current year, student work was collected from one course testing the second module, *High Precision Positioning with Static and Kinematic GPS/GNSS.* The student work showed outcomes related to student understanding of objective 1.1 and student ability outcomes related to objective 1.2. The unit assessments collected from faculty did not include a pre-test so it was not possible to determine whether the student outcomes were an *increase*.

Goal 2. Increase faculty efficacy in teaching geodetic techniques in geology field courses

- *Objective 2.1* Develop robust learning modules for field or classroom use that are flexible enough for instructors to integrate into field camps and classes
- *Objective 2.2* Increase faculty knowledge of best practices for instruction in field courses

In year two, the project has three lines of evidence of progress for Goal 2. First, the piloting and progress of *High Precision Positioning with Static and Kinematic GPS/GNSS* included meeting a rigorous materials development rubric which ensured that the module was of high quality and that the student work demonstrated learning related to the module goals. Second, one instructor tested the materials in three different geoscience courses, demonstrating flexibility across topical areas. Third, the short course end-of-event survey showed that most faculty members perceived an increase in their ability to teaching geodetic techniques in the field (see Table 1).

Goal 3. Obtain baseline data from faculty to better understand successes and challenges of implementing pre-developed curricular materials in field education experience

- *Objective 3.1* Document faculty experience in field instruction, motivation for incorporating geodetic technologies, and working knowledge of best pedagogical practices

Evidence of progress for Goal 3: The project aims to collect instructor stories and structured reflection from faculty who piloted the field materials. During year two, five instructor stories (from four instructors) and one additional structured feedback reflection (from field course participants) have been collected. The structured feedback respondent did not offer open-ended feedback, which limits the understanding of context.

Module 2: High Precision Positioning with Static and Kinematic GPS/GNSS

During this grant period, the second module passed checkpoint 4 (review with the GETSI Materials Development Rubric and revisions), was piloted in one classroom, and reviewed at checkpoint 5 (post-pilot review). The student data reviewed at checkpoint 5 showed that overall the students did accomplish the intended learning goals and module guiding principles, including the societal learning goal that needed work at the time of the 2017 annual report. There was a particular strength in using data and methods, designing and conducting a GPS survey, and developing geoscience habits of mind. Also, there was great use of quantitative skills. Further work includes a second pilot test, piloting the summative assessment questions and associated rubrics (or criteria for grading), and final assessment review and revisions.

Short Course: Using high resolution topography, UAVs, and GPS in undergraduate field education

The second GETSI field short course was held August 15 - 18, 2017 at UNAVCO in Boulder, CO. The goal of this workshop is to equip instructors of geoscience field courses with the knowledge and skills needed to integrate analysis of high-resolution topography into their courses, and featured module 1 teaching resources. The evaluation of the short course was accomplished through a mid-workshop roadcheck and end of workshop survey. Of the 23 short course participants, 22 completed the end of workshop survey. A full report of this event was provided to GETSI leadership. All participants reported value from their field workshop experience, describing either their deepened understanding of the material or the techniques. When asked how they anticipate that the materials from the module *Analyzing High Resolution Topography with TLS and SfM* might most influence student learning, respondents mentioned aspects ranging from accessibility of the material for the instructor and students to being a model to develop additional materials.

> *"I really like the SfM approaches since they are immediately accessible to me and my*

students. I can think of lots of ways to apply what I have learned here to both existing modules in my classes and new exercises."

"Modules will be base from which [I] will most likely develop exercises specific to our department."

Table 1 Knowledge and readiness to incorporate TLS and/or SfM in field courses

Statement	Disagree (slightly, moderately, or strongly)	Agree (slightly, moderately, or strongly)	Statement	Disagree (slightly, moderately, or strongly)	Agree (slightly, moderately, or strongly)
Before the short course I already knew a lot about TLS survey methods and applications (n=22)	55%	45%	I am confident in my ability to explain TLS methods and applications to students (n=21)	19%	81%
Before the short course I already knew a lot about teaching TLS survey methods and applications to students (n=22)	91%	9%	I am confident in my ability to facilitate student accomplishment of Analyzing High Resolution Topography" module learning goals using TLS (n=22)	41%	59%
Before the short course I already knew a lot about SfM survey methods and applications (n=22)	64%	36%	I am confident in my ability to explain SfM methods and applications to students (n=22)	18%	82%
Before the short course I already knew a lot about teaching SfM survey methods and applications to students (n=22)	86%	14%	I am confident in my ability to facilitate student accomplishment of Analyzing High Resolution Topography" module learning goals using SfM (n=22)	23%	77%