

2020

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Recommended Citation

Patrick, L., Thompson, S., Halbritter, A. H., Enquist, B. J., Vandvik, V., & Cotner, S. (2020). Adding Value to a Field-Based Course with a Science Communication Module on Local Perceptions of Climate Change. *The Bulletin of the Ecological Society of America*, 101(3), e01680. <https://doi.org/10.1002/bes2.1680>

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ECO 101

Adding Value to a Field-Based Course with a Science Communication Module on Local Perceptions of Climate Change

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Abstract

Field courses, while generally considered as beneficial for students, are challenging to implement and can lead to strained relationships between local residents and visiting scientists. Thus, it is critical to both maximize the educational value of field courses and help students develop contextualized science communication skills. We report on the development of a science communication module, integrated into an existing field-based ecology course, which aims to add value to an international field course enrolling students from multiple countries. Specifically, students surveyed local residents about their knowledge and perceptions of climate change, and then discussed their findings.

Key words: climate change; field courses; science communication.

Introduction

Benefits of field-based courses

Fieldwork and field-based courses are often preferred teaching methods for faculty and students (Boyle et al. 2007). A field course is a class in which a significant portion of learning involves hands-on

and experiential opportunities beyond the classroom. Field courses often use outside learning and fieldwork (collecting data and using new methodologies in an outside setting) and may be far from traditional classrooms and formal learning environments. It is generally assumed that these experiences are beneficial (Lonergan and Andresen 1988, Harland et al. 2006), with fieldwork being linked to improved learning outcomes in disciplinary knowledge and practical skills (Lonergan and Andresen 1988, Lisowski and Disinger 1991, Kent et al. 1997, Fuller et al. 2014, Thompson et al. 2016, Carpi et al. 2017). Further, learning experiences in a natural environment may also lead to appreciation, respect, and concern for the environment (Fleischner et al. 2017), that is, *nature awareness*. Also, field experiences can increase student motivation for learning (Kent et al. 1997) and promote group interactions, both among students and between teachers and students, creating a beneficial learning environment both during the fieldwork and for any remaining classroom part of a course. Nonetheless, it is unclear whether field courses, independent of the content, contribute to academic development and have a value per se (Harland et al. 2006).

Challenges of field-based courses

Even though it is widely held that field-based courses are valuable for students, offering these courses can be challenging. Compared to traditional lecturing in a classroom setting, field courses can be demanding for teachers and students. Field courses are generally more expensive and have additional health and safety challenges. For example, field courses typically occur off campus, requiring students (and instructors) to travel to get to the field site, pay for food and lodging while they are there, and potentially to invest in appropriate field gear. In addition, field courses (and fieldwork generally) pose risks to students due to adverse weather, terrain, and dangerous plants and animals. Therefore, they require more planning and internal resources than traditional lecturing in a classroom setting. From the management point of view, the benefits of field-based education must be evaluated against the increased investments of time and money.

Further, field scientists have been criticized for their role in bolstering the “parachute model” of place-based research (Bastida et al. 2010, Castleden et al. 2012, Sehrsweeney and Robertson 2018); that is, the scientists drop in to a community without warning, collect their data, and quickly depart, often failing to regard the human inhabitants as sources of valuable information or critical participants in the ecosystem. For example, understanding how a changing climate can impact indigenous communities in the Arctic is of interest to climate scientists. Indeed, there has been a proliferation of research on the human dimensions of climate change (Ford and Pearce 2012). This type of work inherently involves researchers engaging with local communities to better understand how those communities are impacted by climate change. However, if care is not taken, these interactions can quickly turn exploitative. Unequal power dynamics between researchers and local communities can lead to minimal involvement of local communities in the research process (Castleden et al. 2008, Gearheard and Shirley 2009, Pearce et al. 2009). Therefore, it is pivotal for developing researchers engaging in work on the human dimensions of ecological disturbances, such as climate change, fire, and habitat fragmentation, to gain experience with research methods that actively involve members of the local communities where the research is conducted.

Making field courses more cost-effective

One way to increase value for money is to integrate student fieldwork or courses into an active research program. Such a combination can be valuable, leading to increased interest in the subject as well as improved understanding of the methods used and of the research process more broadly (Fuller

et al. 2014). As field time may provide unique opportunities for instructors to collect data for their own research, and for students to become actively involved in ongoing research, this also creates win-win situations for students, instructors, and institutions. Course-based research experiences, in the field (Thompson et al. 2016) and otherwise (Mader et al. 2017, Hanauer et al. 2018, Kirkpatrick et al. 2019), have thus emerged as a solution to multiple challenges.

Another way to increase value is to help students make connections with the local communities at or near the field sites. Communication between residents and students has the potential to give the students a broader perspective of the value of the study area to those individuals that are most intimately familiar with the flora and fauna, while helping disrupt the negative associations locals may have with scientists following the parachute model of ecological, or place-based, research. As an example, Sehrsweeney and Robertson (2018) describe how, as students at a field site in the Yukon, they surveyed local residents to assess the residents' perceptions of a long-term and ongoing ecological project nearby (specifically, the Kluane Red Squirrel Project). And Doering and Hendrickson (Doering et al. 2015) attest to the positive impact, on K-12 students, of hearing indigenous voices from around the globe speak about their experiences with climate change. Further, helping students make these connections could give them a broader appreciation for local ecological knowledge (LEK) and its potential. For example, other researchers used LEK to document decline in the artisanal fishery in Brazil (Bender et al. 2014).

The added challenge of polarizing environmental issues

Scholars studying socially polarizing topics, such as climate change science, may realize an added benefit of engaging with the community near their field sites: Specifically, they may develop a nuanced awareness of some of the factors contributing to polarization. Researchers may also gain critical insights about the systems they study from the people who live in the area full time. For example, Green et al. (2010) describe how Australian Aboriginal knowledge informs an understanding of phenology changes due to climate change.

Adding value via a science communication module

We describe the addition of a small (<1 full day), science communication module (SCM) to an international, ecological field course. The main aim of this field course was to train students in functional trait-based methods for exploring the impacts of climate change on biodiversity and ecosystem functioning, while collecting data on these issues aiming to result in collaborative publications between instructors and students (e.g., Henn et al. 2018). The course was open to both graduate and undergraduate students, and the participants were biology, ecology, and geography students from multiple institutions and nationalities. The communication module served to embed the main natural science content of the course, and their education more generally, in a wider social science and local community perspective. Specifically, students surveyed local residents, near field course study sites, about their knowledge and perceptions of climate change, and then students discussed their findings, in both local and global contexts.

Our primary goal was to develop and assess an SCM (emphasizing learning *from* local residents, rather than teaching *to* them) that aims to add value to a field course. While we describe our international field course enrolling students from multiple countries, and compare outcomes from two very different geographical settings, our methods are easily generalizable to single-site studies and other field course contexts. Our primary assessment questions were as follows: (1) Is the addition of the SCM feasible in

this context? (2) Do students perceive value in the module? And (3) specifically, what do students value about the module, and what changes do they suggest?

Methods

Student population

The focal population involved two groups of students (both undergraduate and graduate students) enrolled in two different offerings of a “Plant Functional Traits” course. This two-week course, developed by scientists from Norway, China, and the United States, aims to train an international group of emerging scholars in functional trait-based methods for studying ecosystem responses to climate change in a realistic research project setting (see below). A Peruvian course enrolled 22 students from 12 countries (including Australia, Brazil, Columbia, Germany, Norway, Spain, and the United States) and involved faculty leaders from Norway, the United States, and the UK. A Norwegian course enrolled 26 students from 11 countries (including Brazil, Canada, the Czech Republic, Finland, Iceland, and Peru) and involved the same Norwegian and US faculty leaders.

Locations and course activities

In Peru, course activities were centered in four locales in the Department (province) of Cusco: the city of Cusco (13°31'30"S 71°58'20"W, population ~430,000), the village of Paucartambo (13°18'56"S 71°35'30"W, population ~14,000), the Wayqecha Cloud Forest Biological Station, and Písaq (13°25'27"S 71°51'28"W, population ~10,000). In Cusco city, activities centered on course orientation and involved lectures, course discussions, and “get to know you” sessions. Students were also oriented to the SCM and spent ~2 hours surveying residents of Cusco in the city center. In Paucartambo, a short stop en route to the field station, the primary activity was surveying or interviewing residents of the town. At Wayqecha, students were immersed in fieldwork during the day (collecting data on plant traits for the trait wheel, described above) and a combination of laboratory work and lectures in the evenings. Students completed the course in Písaq, spending three days in a data management and data analysis workshop.

In Norway, course activities were centered in and around the village of Longyearbyen (at 78°13'N 15°38'E, population ~2200) on the island of Spitsbergen in the Svalbard archipelago, in the Arctic Ocean. SCM surveys took place in the town of Longyearbyen and on a glacier tour boat cruise. Students were encouraged to collect survey data on their own over the course of ~4 days; in addition, during one concentrated ~2.5-hour data collection session on the fourth day, all student participants surveyed residents. Survey respondents included tourists (largely from Northern Europe) and long-term residents of Svalbard predominantly working in education, energy (coal), and tourism.

The plant functional traits course

The TraitTrain International Plant Functional Traits Course (PFTC) aims to offer a hands-on experience with collecting and exploring plant functional traits data in a real-life field research project setting, along with an introduction to the use of plant trait data in climate change research and ecosystem ecology (field methods, laboratory methods, and data management). Typically, students are divided into four groups that have different projects and responsibilities, but all groups help each other in the field and

laboratory. The goal is to produce real, publishable datasets, while teaching students applicable field and laboratory skills. Ideally, students will spearhead manuscripts with these data (e.g., Henn et al. 2018). The course originated at the Gongga Mountain Research Station in China in 2015. Early input indicated that students would like to feel more connected with the community, so the curriculum changed in 2017 to incorporate the SCM for course offerings in Peru and Norway.

The course is advertised online and heavily promoted on social media (e.g., Twitter, Facebook) and various academic channels (e.g., societies, mailing lists). The advertisements describe the content and goals of the course, and the students are asked to provide an application letter and a CV. Applicants are also asked to rank their interest in the four different course projects (e.g., assessing how temperature variation and leaf functional traits influence leaf ecophysiology). The call attracted 50 applicants to Peru and 54 to Svalbard.

The science communication module

The SCM took place in three stages: pre-survey orientation; surveying local residents; and discussing survey results in a local and global context. This module was led by either Sehoya Cotner (SC; Peru) or Lorelei Patrick (LP; Svalbard), who had attended science communication workshops prior to development of the module. During pre-survey orientation, one of us (SC or LP; both educational scientists) led students in an interactive discussion of the “science communication problem,” in which students cited their own funds of knowledge to make the case that the inability of scientists to communicate effectively has tractable real-world costs. Commonly cited issues were resistance to childhood vaccination, concerns over genetically modified foods, and rejection of climate change science. In Svalbard, the discussion started by pointing out (a) the need for scientists to first listen to stakeholders and (b) how LEK can be leveraged by scientists studying climate change. In both courses, discussion then centered on factors that can lead to polarization (e.g., identity protective cognition, lack of information, distrust of scientists) and strategies scientists can take to communicate more effectively. This first stage concluded by introducing the “Perceptions of Climate Change Survey” and associated surveying strategies. Next, students were given opportunities to survey local residents, using survey forms printed in English and, depending on context, Spanish or Norwegian.

During the survey phase, students, usually in groups of two or three, approached individuals in the towns of Cusco, Paucartambo, Longyearbyen, or other locations around Svalbard. They explained that they were students interested in local perceptions of climate change and asked each person if they would be willing to complete an anonymous survey or answer survey questions in an interview format. In Peru, groups were arranged to ensure at least one native Spanish speaker per group. The interview, rather than survey, option seemed particularly appealing in Paucartambo, where most residents speak Quechua as a first language, and may have been less comfortable reading and writing in Spanish. On Svalbard, respondents preferred to fill out the survey (printed in either English or Norwegian) themselves. In order to increase the number of responses, groups of students also spent two hours on one evening knocking on doors in different neighborhoods in Longyearbyen. After each person completed the survey, they were offered a small “thank you” pair of sunglasses (valued at <\$2). The total amount of per-student time dedicated to survey collections was ~4 hours for each two-week course.

The survey itself (available in full in Appendix S1) asked respondents about their knowledge of climate change (e.g., “How well do you feel you understand the issue of climate change/global warming?”), their

perceptions of the threat posed by a changing climate (e.g., Likert-scale agreement with statements such as “Climate change poses a serious risk to *my or my family’s*, health, safety, and prosperity”), and their own personal experiences, if any, with climate change (e.g., “Have you personally noticed any impacts of climate change?” [yes/no] and “If yes, please describe”). The survey was constructed initially in English, drawing on identical or similar items in other surveys about knowledge and perceptions of climate change (Demski et al. 2017; Kahan et al. 2017). For the Peruvian survey, a native Spanish speaker translated the survey into Spanish, and two additional Spanish speakers (including one from Peru) made slight modifications for clarity. For the Norwegian survey, a bilingual graduate student affiliated with the project translated the survey, which was then approved by one of the Norwegian instructors (Vigdis Vandvik).

After survey collection, one of us (SC or LP) entered and organized the data for later discussion. During the final phase of the SCM, students were encouraged to make predictions about the data they had collected and then were given the results and some time for reflection. Data were discussed in light of international trends on perceptions of climate change, and students suggested factors that may have led to climate change acceptance, rejection, concerns, or misconceptions (e.g., in Peru, many survey respondents talked about “contamination” and “pollution”). Finally, students were encouraged to write a short description of their own work at the field station, but geared toward the local population, with newfound knowledge of this population’s perceptions of climate change. In Svalbard, the organizers compiled these descriptions into a letter to the editor of the local newspaper. This letter was published after course assessment was completed.

Assessment

Assessment consisted of data from the students’ end-of-course surveys (available in Appendix S1). The end-of-course survey was written to elicit feedback on a variety of course elements, with a few items specifically targeting the SCM experience. For example, students were asked to respond to items, using a Likert scale for agreement, such as “It was worthwhile to survey/interview individuals in Cusco/Paucartambo/Longyearbyen” and “I was interested in the data we collected.”

Finally, one open-ended question included this prompt: “As a reminder, our goals of this mini project were to (1) learn about inter- and intra-cultural variation in knowledge and perceptions of climate change and (2) appreciate how cultural differences create unique challenges for science communication. Our desired outcome is for you to develop thoughts on how you, as a scientist, can take cultural considerations into account as you discuss your work and its implications. We would love to know your thoughts. Outreach and communication are part of the course, and there are many ways to accomplish the goals listed above. What was valuable to you? What would you change?”

Surveys were emailed to students immediately after the course concluded, and reminders were sent until all students had completed them (~2 weeks later).

For qualitative data, we used a hypothesis coding framework (Saldaña 2015) to identify student responses as belonging to one or more of the following categories: generally positive about the SCM; generally negative about the SCM; a mix of positive and negative impressions; and specific suggestions for improvement. During coding, two additional categories were revealed and added to the coding list: language barrier and not enough time.

Do students perceive value in the module?

On a pre-course survey, students were asked a few questions related to the SCM. Their responses are summarized in Fig. 1. In general, students agree that it is important to develop science communication skills and that it is valuable to consider cultural differences in perceptions of climate change. Students in the Peru course found interviewing local residents a little more valuable (average of 4 out of 5, or “agree”) than did students in the Svalbard course (average 3.7 out of 5). Conversely, the Svalbard students were a little more interested in the data they collected during the SCM (average of 4) than were students in Peru (average of 3.75).

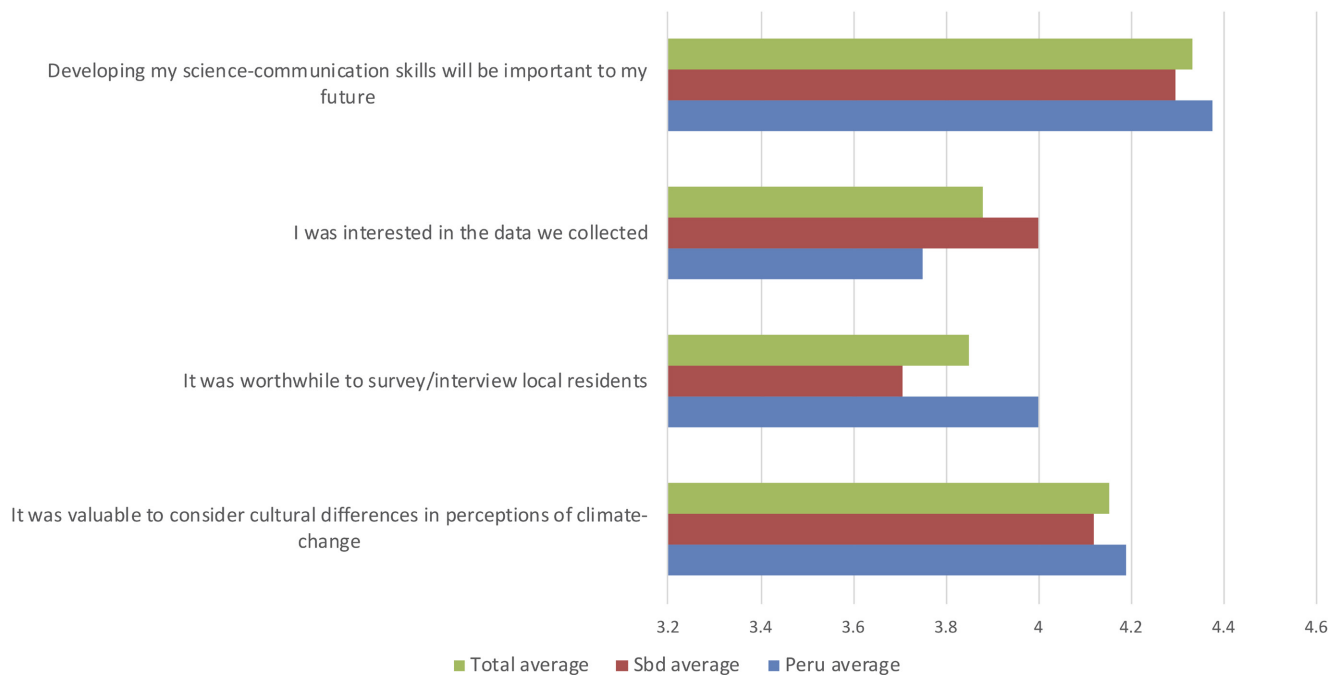


Fig. 1. Average student impressions of the science communication module. Average responses for each item are based on a 5-point scale, where 5 = strongly agree and 1 = strongly disagree.

Specifically, what do students value about the module, and what changes do they suggest?

To address this question, we analyzed student responses to the prompt concluding “What was valuable to you? What would you change?” We identified student responses as belonging to one or more of the following categories: generally positive about the SCM; generally negative about the SCM; a mix of positive and negative impressions; and specific suggestions for improvement. Two subcategories emerged under the category of “specific suggestions”: language barrier and not enough time. Table 1 summarizes these student comments. Ten students from Peru, and 15 from the Svalbard course, responded to this survey item.

Table 1. Summary of student comments about the value of the science communication module.

Category	Number of responses (out of 25 total)	Examples
Overall positive	16	<ul style="list-style-type: none"> • I enjoyed approaching people at random, improvising the conversation based on the specific person. It was humanizing. This is the hard work, but just being personable to other people lets us make contact with the people who should know what we're doing • It was totally valuable for me because to be honest I have never thought about how to communicate science to non-scientist people and with very different backgrounds
Overall negative	5	<ul style="list-style-type: none"> • I disliked having to knock on people's doors and disturb their privacy. I didn't feel that people benefited from answering our survey - I felt they were just doing us a favor • I think this part was too much. I'd rather have used the limited time we had to focus on trait-related issues
Mix of positive and negative	2	<ul style="list-style-type: none"> • I am intrigued by the information we were able to draw from the survey data. I also enjoyed the opportunity to wander around and talk to people. However, I don't think our surveys encouraged much dialogue outside of the questions posed, nor did they provide an obvious benefit to the people we interviewed • It is interesting to compare this in different cultural background, so it was nice and valuable to have results of our surveys both from Peru and Svalbard. The way of surveying people in Longyearbyen was though a bit uncomfortable for me and I guess that for the questioned people might have been too - I would prefer a more anonymous, possibly internet version of questionnaires
Suggestions for improvement	15	<ul style="list-style-type: none"> • Maybe [provide] the opportunity to discuss and submit questions for the surveys and propose our own hypotheses in a visible way before assessment • This was valuable for me, however I would have also liked a bit on suggestions on how to communicate/outreach science. Maybe examples of materials or workshops others have done and that we could do
Language barrier	3	<ul style="list-style-type: none"> • I think the whole exercise of carrying out surveys was flawed from the start since a large portion of the course participants were not able to communicate with the locals • [E]nsure that native speakers are always present in these types of situations in the future!
Not enough time	3	<ul style="list-style-type: none"> • I would really like if we spent more time interviewing more people • I would add more time gathering this kind of data

Discussion

Both the Peruvian Andes and Svalbard are focal sites for studies of climate change ecology. Climate-induced reductions in Andean glaciers are well documented and expected to have serious implication for water availability for local communities (Vuille et al. 2008). Similarly, the High Arctic has become a poster child of climate research, with many well-documented impacts on wildlife communities

(Descamps et al. 2017). Thus, it is reasonable to assume that individuals living at or near both these sites would be aware of climate change, have knowledge of or personal experiences with climate change researchers working in their immediate surroundings, and possibly be eager to share their thoughts on the subject. Consequently, these sites seemed ideal for incorporating an SCM into our field course. Our hope was that emerging ecologists would find a receptive audience, thus allowing these students to reflect on the value of local knowledge and the need for effective communication with local residents.

Generally, the SCM succeeds in meeting our goals. The module was feasible within the course context and area residents were receptive to the student surveys, students perceived value in the module, and their perceptions of value aligned with our motivations for adding the course. Specifically, students were interested in the data they collected, realize the value of considering local cultures during climate change work, and feel that developing their science communication skills will be critical to their future work. These findings are encouraging, because while exposure to content and learning outcomes will change during a graduate student's academic progression, some aspects of the work described here, for example, the need to connect with both local and global communities, are unlikely to change. Arguably, the need to communicate with these communities may be *at least as*, if not more, important for their postgraduate work. These students will soon be in charge of their own projects, working in different areas of the globe, and if they are willing to communicate with local residents (e.g., to gain access to field sites, learn from LEK, and gain new collaborators), they are more likely to be successful.

We did note some slight differences in student perceptions between the two field courses, and considering these differences (and their possible causes) informs our suggestions for future implementation. Some differences in student perceptions of the SCM could be due to differences in the timing of the module during the course. In Peru, the SCM was implemented at the beginning of the 2-week course, when most of the course time was devoted to teaching course participants about climate change and plant functional traits. The SCM served as a way to collect data before going to the field station and seemed to work in part as a team-building exercise. Because this module was at the beginning and data collection lasted only a few hours, the SCM provided the first results generated by the course, which in turn buoyed the participants' enthusiasm.

However, feedback from the Peru student suggested that the course information was too front-loaded, so the decision was made to move the SCM to the end of the Svalbard course. However, by this time, the students had already formed teams, were collecting plants at field sites for several hours each day, and were collecting functional trait data when they were at the field station laboratory. This entrenchment in their own research may have limited student enthusiasm and the amount of time available to collect survey data. In addition, Longyearbyen is a very small town without a large market space, like in Peru, and tourists in Longyearbyen were loath to spend their limited time on Svalbard answering survey questions, necessitating the door-knocking strategy we employed to increase our sample size. In addition, the Peruvians may have been simply easier to approach and engage in conversation, while the Svalbardians are more reserved. Combined, these factors led many of the students to feel uncomfortable collecting survey data and to report the sense that the SCM was "tacked on" to the course.

Several students felt that there was insufficient time to complete the SCM and really delve into a discussion of how to address science communication challenges. And, while our primary goal was simply to stimulate thought and conversation about these issues, we appreciate student concerns about

insufficient time. Further, several students wanted more ownership of the study design and suggested letting future students develop some of the survey questions to address student-generated hypotheses about local perceptions of climate change. Finally, several students expressed interest in learning additional transferable science communication skills. In particular, students were interested in learning how to create infographics and how to better communicate their findings to broad audiences.

For future SCM implementation, we plan to make the following changes in response to student feedback:

- We will strive for better integration between the field course, in general, and the SCM. For example, this integration could include survey items specifically asking residents questions related to the course topic. Target questions related to plant phenology changes observed by residents could help inform the plant functional traits questions investigated by the students. We will also incorporate the SCM from the beginning of the field course.
- We will give students added ownership of the survey itself. Where possible (e.g., where we have access to a printer and copier), we will include students in a pre-survey discussion of their own questions about how the local residents perceive climate change. This discussion may lead to the addition of survey items (after the previously validated metrics) specifically addressing student interests, hopefully increasing student buy-in and potentially leading to richer discussions with locals.
- During the data analysis part of the course, some students will have the option to work with SCM survey data and will be encouraged to further develop these findings into infographics, etc., to be shared with local communities.
- When possible, we will include some more time for reflection on survey findings and specific suggestions for how effective science communication at field sites may lead to mutual benefit.

In their review of successful (and not-so-successful) community-based conservation projects, Brooks et al. (2012) assert that success is often associated with deliberate capacity building in the local communities; these findings confirm the need for future scientists to build their own capacity in effective two-way communication with local residents. The work described herein, although only a small component of a two-week field course, suggests that future scientists (i.e., current graduate students) are aware of these demands and eager to contribute to communication solutions. We find this positive response to the SCM encouraging, because in our increasingly polarized world, science communication skills will be critical for scientists and should therefore become a fundamental aspect of student training in ecology.

Acknowledgments

We are grateful to our students for collecting data and community participants for their willingness to share their views and experiences, and we acknowledge the financial support of the Norwegian Research Council (project 274831 RECITE under the INTPART program) and the Norwegian Centre for International Cooperation in Education (project 2015/10037 under the High North program).

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Supporting Information

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