

LONG-TERM IMPACTS OF A CAREER DEVELOPMENT WORKSHOP FOR UNDERGRADUATES

VALERIE SLOAN, REBECCA HAACKER, TIM BARNES, AND CAROLYN BRINKWORTH

The Undergraduate Leadership Workshop at the National Center for Atmospheric Research is a successful model for cocurricular student engagement and retention in atmospheric sciences.

There is a growing need for atmospheric scientists in many different sectors of the workforce (U.S. Bureau of Labor Statistics 2012); however, undergraduate students in this field are often unclear about career options, especially outside of academia. Summer research experiences or internships can provide insights into career paths, but these are competitive, and only about one-third of geoscience graduates participate in such experiences (Wilson 2014). In some cases, students are not able to participate in summer-long internships because of family circumstances (Dalbotten et al. 2014).

The Undergraduate Leadership Workshop (ULW) at the National Center for Atmospheric Research (NCAR) offers an opportunity for students to explore atmospheric science careers in a different way. The week-long ULW introduces about 20 talented students, mostly juniors, to research being conducted at NCAR, graduate school in the atmospheric sciences, and future opportunities in weather and climate careers. Participants take their experience back to their own institutions to share information about careers and NCAR with their peers. While a short program like the ULW cannot train students in research, it still helps them make informed choices about career options, excites them about their future paths in this field, and provides them with training in essential nontechnical skills that will help them succeed in school and STEM careers.

METHODS OF ULW. The ULW recruits undergraduate students who major in the atmospheric and related sciences at University Corporation for Atmospheric Research (UCAR) member institutions and partnering minority-serving institutions (MSIs). Faculty nominate participants based on their academic strength and leadership record or potential as demonstrated in class or clubs. So far, 269 college students have participated since 2002, and more than 70 universities

AFFILIATIONS: BRINKWORTH AND BARNES—University Corporation for Atmospheric Research, Boulder, Colorado; HAACKER AND SLOAN—University Corporation for Atmospheric Research, and National Center for Atmospheric Research,* Boulder, Colorado;

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CORRESPONDING AUTHOR: Valerie Sloan, vsloan@ucar.edu

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have nominated and cosponsored students to attend (Barnes and Haacker-Santos 2014). Costs of the ULW are shared between NCAR and the participating universities, who cover the travel expenses for the student they nominate. In an effort to make the ULW accessible to all students, NCAR provides additional funding for students from MSIs and small colleges if needed. The ULW is advertised to all UCAR members at the American Meteorological Society (AMS) Annual Meeting and through past nominating faculty members and ULW alumni.

The students come together for a week-long intensive workshop in Boulder, Colorado during the summer. This is led by two experienced UCAR science educators. The workshop is organized using three themes:

1) Exposure to science careers: A goal of the ULW is to introduce students to a variety of careers in the atmospheric sciences in hopes of raising awareness about options and increasing interest in this field. Participating students hear from NCAR scientists about their research and career paths and visit NCAR's scientific laboratories and aircraft facilities (Fig. 1). They engage with panelists from research, academia, and the private sector to learn about work in these sectors. Students also meet one on one with scientific mentors and receive in-depth, individualized career advice, which has shown to be impactful for students (Haacker 2015).

To make the learning more meaningful, hands-on, and interactive, the ULW added a

group project on developing career profiles in 2015 and 2016. In this project, students work in groups of three to interview scientists, engineers, software engineers, science educators, and science communicators about their work and produce materials for sharing. In 2015, students produced videos of their interviews, and in 2016, students created newsletters, websites, slides, embedded videos, and a monthly career magazine. These were intended as models of materials that could be used for disseminating career profiles to students and graduate students interested in the atmospheric sciences. The students presented their projects at the end of the week.

2) Leadership training: The ULW has developed a leadership model based on service to society and inclusion. First, students meet with NCAR leadership to hear about the leaders' roles and experiences. In a series of seminars, students then work to identify characteristics of good leaders, discuss what informal leadership looks like, and learn to lead using values to guide their choices and actions. They practice listening, respecting diverse opinions, and encouraging their team members to lead in individual areas of strength.

3) Professional development: Employers have stated that soft skills, in addition to technical skills, are key when evaluating applicants for a position (The Chronicle of Higher Education 2012; Furgione et al. 2014). These skills are not taught consistently in college, so short courses enhancing these skills are beneficial. In their team projects on career profiles, students gain experience in working in

teams, managing a project, meeting deadlines, and presenting their materials and insights to others, with guidance from staff throughout the process. In addition, the students participate in seminars that cover communicating professionally via e-mail, giving elevator speeches, goal setting, and incorporating the experiences and skills from the ULW into their résumés.

Built into the three themes are team-building and peer-networking activities so that participants who



FIG. 1. Students in the 2016 ULW visiting the NCAR Research Aviation Facility.

come from around the nation can create connections and support networks. In addition, ULW participants interact with other interns and postdoctoral fellows at NCAR and with ULW alumni who are now graduate students. Students participate in cohort-building exercises that may include games, a group hike, and a tour of a nearby mountain park. Small groups self-organize for dinners and exploration of Boulder, Colorado. The week concludes with a review of the workshop. Figure 2 shows an example of an agenda for the ULW with the different components.

PROGRAM EVALUATION. Over the history of the ULW, formative evaluations of daily activities using both discussions and daily surveys have been conducted. NCAR leaders who have been involved each year and UCAR members who have had students attend the ULW have also provided insight and suggestions that have been incorporated to continually improve the workshop. Each year, staff have modified the program slightly with the intention of improving it. Long-term tracking of participants has been limited to staff efforts to keep in contact with ULW alumni.

This study represents the first effort to assess the impact of the ULW on students' careers and how those impacts could be compared to other educational experiences such as internships and research experiences for undergraduates (REUs). An additional goal was to better understand which program elements were seen as most effective. For the purpose of the focus groups and online survey, ULW staff made a concerted effort to reach as many of the 269 past participants as possible. A total of 114 alumni were successfully contacted and invited to participate. The evaluation was conducted by the GEO REU Resource Center at UCAR, which provides support for leaders of Research Experiences for Undergraduates in the geosciences.

FOCUS GROUPS. In January of 2015, the first step of a summative program evaluation involved hosting focus group discussions with 35 ULW alumni who attended the 2015 AMS Annual Meeting. Three groups of ~12 alumni each met for 1.5 h to answer a series of questions. During that time, they had conversations about their current occupations, career paths, and the impact of the ULW on them.

Time	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
8:30 AM	Travel to Boulder	Welcome	Check-in	Check-in	Check-in	Check-in	Depart for home
9:00 AM		Introduction to the ULW	Research talk: climate science	Research talk: meteorology	Research talk: societal impacts	Session: communicating to all audiences	
10:00 AM		Meet the NCAR Director	Team projects: exploring careers in the atmospheric sciences	Team projects: exploring careers in the atmospheric sciences	Team projects: exploring careers in the atmospheric sciences	Final presentations	
11:00 AM		Introduction to team projects					
12:00 PM		Lunch	Lunch: conversations with scientists	Lunch: conversations with scientists	Lunch	Final lunch	
1:00 PM		Tour of Mesa Lab	Career panel: private sector	Career panel: academia	Leadership training	Evaluations and looking forward	
2:30 PM		Informal leadership & leading with values	Prof. dev seminar: résumés/CVs	Prof. dev. seminar: graduate school	Prof. dev. seminar: communicating & managing	Visit NCAR's Research Aviation Facility	
3:30 PM		Organizing teams for career profile projects	Cohort-building game	Cohort-building game	Tour of instrumentation lab		
4:00 PM		Hike on Walter Orr Roberts Weather Trail	Project time	Project time	Final preparation of project		
5:00 PM		Welcome event and ice-breaker	Bus to dorms	Bus to dorms	Bus to dorms	Bus to dorms	
Evening		Evening free	Student Potluck dinner	Evening Free	Student Potluck dinner	Free time	

FIG. 2. A sample agenda showing the types of activities during the ULW.

The focus groups were audio recorded and later analyzed. The general themes that emerged informed the design of the online survey sent to alumni. The feedback gained in this first step also helped guide the ULW program design for summer 2015, for example, by including more discussion of private sector careers.

ONLINE SURVEY. In November of 2015, the summative evaluation of long-term impacts of the ULW was completed with an anonymous online survey of the 114 alumni for whom contact information was available. The goal was to learn about the career paths of ULW alumni and how they saw the impact of the ULW experience looking back on it. The survey included 21 questions consisting of Likert-scaled matrices and several open-comment-box responses. A total of 71 alumni responded to the survey, which is a 61% response rate of alumni contacted and a 26% response rate of alumni overall. There was an average of four respondents and at least one respondent for each year of the ULW from 2002 to 2015, with 20% of the respondents having participated in 2015. While this is a high response rate and captures feedback from the duration of the ULW, there was no information from those alumni who opted not to answer the survey or the alumni for whom we did not have contact information.

SURVEY RESULTS. *Academic pathways.* The ULW is open to undergraduate students in atmospheric and related sciences. All alumni reported working on or having completed a bachelor's degree. Most were majoring in the atmospheric sciences and meteorology (91%) with the rest either majoring or double majoring in math, environmental science, physics, engineering, oceanography, geography, geoscience, sociology, or education.

A total of 80% (57 out of 71) of the survey participants indicated that they were pursuing or had earned a graduate degree in a science, technology, engineering, and mathematics (STEM) field. Of those degrees, 72% were in the atmospheric sciences or meteorology; most others were in the environmental or Earth system sciences; and a few were in health, education, or urban planning.

Exposure to careers in the atmospheric sciences. One of the recurring themes in the focus group discussions was that students found the ULW experience to be “eye-opening and inspiring” regarding the world of atmospheric research and careers in meteorology, atmospheric science, or related fields. Similarly, in the survey results, 90% strongly agreed or agreed that the

ULW “introduced me to new career opportunities.” One alum wrote, “I learned about the nonlinear paths in this field,” while another commented that the ULW “gave great perspectives on life as a scientist, [and] a view of NCAR facilities and cutting-edge research.” One expressed appreciation for the chance to meet and learn “from scientists who successfully navigated grad school and post docs [who] ‘made it’ in the field.” “It was an excellent opportunity to see NCAR facilities and inspired me to continue in my chosen field of meteorology to advance science and technology,” commented one alum.

The results show that 90% of the survey respondents indicated that the ULW “provided an experience that helped to prepare me professionally” (Fig. 3). Additionally, 84% of survey respondents reported that the ULW “increased my confidence in my ability to pursue my career.” Confidence building is an often-cited benefit of longer summer research experiences (Estrada 2014; Hunter et al. 2007). After having heard about the meandering career paths of several scientists, one participant in the 2016 ULW stated at the end of the week that “for the first time since high school, I am not afraid of my future.” Another said that it was reassuring to know that there is not one right path to becoming a scientist.

Students report on their experiences and information gained in the ULW program to their peers during the following academic semester, either in a class setting or a discipline-related club meeting. One student wrote about their presentation that “everyone...had tons of questions. They were particularly impressed with the career options and couldn't believe we covered so much in only one week. I'll be presenting to my engineering club as well. I love sharing these opportunities with everyone.”

Sense of belonging. Research is starting to show that creating a supportive community and a “sense of belonging in STEM” in cocurricular programs can help students persevere in STEM fields (Walton and Cohen 2007; Huntoon et al. 2015). The creation of this sense of belonging is well documented in the internship and REU community (Seymour et al. 2010).

The second theme that emerged from our evaluation was that in the ULW, the students felt that they had found like-minded people and a group in which they felt they belonged. One of the alumni wrote that “becoming a member of [the ULW] community is vital to how connected I feel to the field.” Although many of the ULW participants study meteorology and benefit from supportive faculty and peers at home, finding “other weather enthusiasts from around the

country” was seen as beneficial by the students. For students at smaller schools with no meteorology program, this community building seemed particularly important: “It’s a great way to meet others who share your nerdy interests.”

Developing a professional network. In the survey, 75% of the respondents indicated that the ULW had supported them in developing a professional network. As one alum said, “Not only do you have the opportunity to network with scientists and researchers, you also gain a new cohort of passionate students who are finding their way through atmospheric science and related fields too.” Another wrote that “I am still in touch with the vast majority of people that I participated with and almost all are in meteorology in some capacity.” One alum commented that “the primary benefit was the long-term connections and leadership development. For these two reasons alone, the ULW is invaluable.”

The steady growth of social media in the past decade has extended the value of this network by allowing people to see the range of careers that their peers have pursued. As one alum wrote, “I have kept up with my ULW cohort, watching (from Facebook, usually) individuals go on to graduate school, careers in forecasting, broadcast meteorology, research at

NASA and NOAA, etc. It is an invaluable resource to have connections with peers and experts as early as in undergrad.” NCAR is working to strengthen this part of the program by offering ULW alumni events at the AMS Annual Meeting and by continuing to manage a public Facebook page with career tips and updates on alumni accomplishments.

Decision to attend graduate school. Research has shown that welcoming students early into the science community by engaging them in research activities will increase their interest and retention in STEM fields (Lopatto 2009). Several studies have tried to quantify the impact of research experiences. For example, Bauer and Bennett (2003) found that 43% of STEM alumni at the University of Delaware who participated in summer research pursued a doctoral degree, while only 23% of alumni who did not engage in summer research experiences pursued doctoral degrees. Of the ULW survey respondents, 71% indicated that participating in the ULW helped them “to decide to go on to graduate school,” while 15% said that it helped them to decide not to pursue a STEM graduate degree or to pursue another, nonscientific professional degree. Another 14% indicated that the experience did not modify their intentions.

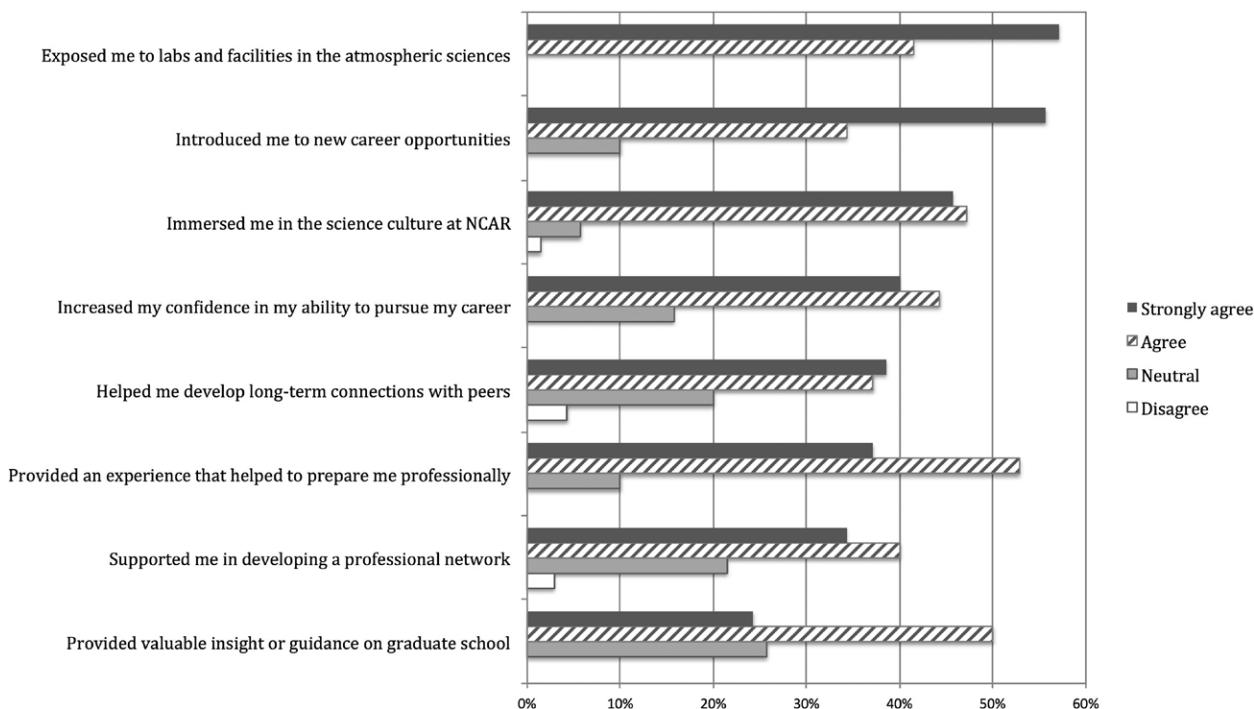


FIG. 3. Survey results for the question “How much do you agree with the following statements? The ULW...” The x axis shows the percentage of respondents who chose each level of agreement. The sample size, $n = 70$, represents program years 2002–14 with at least one respondent for each year. No one selected “strongly disagree” for any of their responses.

Where are they now? The evaluation found that the majority of the survey respondents are in STEM careers. All but one reported being employed, with 67% indicating that they worked full time; 30% worked part time or as graduate students, and 3% were caring for family. The majority reported working in fields related to the atmospheric sciences. Of the respondents, 53% were in academia, including faculty, graduate students, and K–12 teachers; 22% were in government positions; and 25% were in private and nonprofit organizations. Several alumni reported working as operational meteorologists in the private sector and in the National Weather Service. One was a pilot in the National Oceanic and Atmospheric Administration (NOAA) Corps at the Aviation Weather Center and another was a bathymetric scientist in the Naval Oceanographic Office.

CONCLUSIONS AND RECOMMENDATIONS.

The Undergraduate Leadership Workshop at the National Center for Atmospheric Research was created in 2002 to engage undergraduate students in the atmospheric sciences and encourage them to pursue a graduate degree or career in STEM. Informal feedback from participants and nominating faculty has confirmed the popularity of the program over the years, but a formal, summative evaluation showed that the grand majority of survey respondents (98%) saw the program as a very valuable or valuable experience. All but one of the respondents wrote that they would recommend participating in the ULW, and most elaborated with very positive comments like “Such an amazing experience!”

The results of the program evaluation suggest that the overall value of short but intense programs with opportunities for exposure to careers, professional development, mentoring, and peer-relationship building have a significant positive impact without the effort or cost of a full-fledged internship. This study shows that the program outcomes for participants have included 1) the development of a long-term and close professional network of peers, 2) a sense of belonging to a group of students with similar interests, 3) a raised awareness of the wide range of career pathways in the atmospheric sciences, and 4) an increase in interest in pursuing a STEM graduate degree or career.

While this program provides some of the elements of a summer research internship program, it obviously does not train students in doing scientific research. However, this study shows that a short but well-executed program of this type can provide some of the experiences and training that have been shown to be effective in REU programs (Estrada 2014;

Lopatto 2009). Specifically, ULW alumni reported that this experience was significant in raising awareness and interest in geoscience careers and in developing a sense of cohort that carried on through their professional careers.

The key activities that serve to accomplish these outcomes include

- 1) career panels encompassing the academic, government, and private sectors;
- 2) opportunities to converse with and hear from scientists in several scientific subfields about their fields, career paths, and lives in science;
- 3) team-building activities such as small group projects, field trips, and short games;
- 4) training on communicating professionally, including giving elevator speeches; and
- 5) leadership training, including informal leadership and working in teams.

Based on these findings, we hope that workshops of this scale may be considered at other research centers or in atmospheric science programs so that more students can benefit from this type of training and support. It may be that similar programs exist at other institutions, and it would be interesting to see if they also observe significant impacts on their participants.

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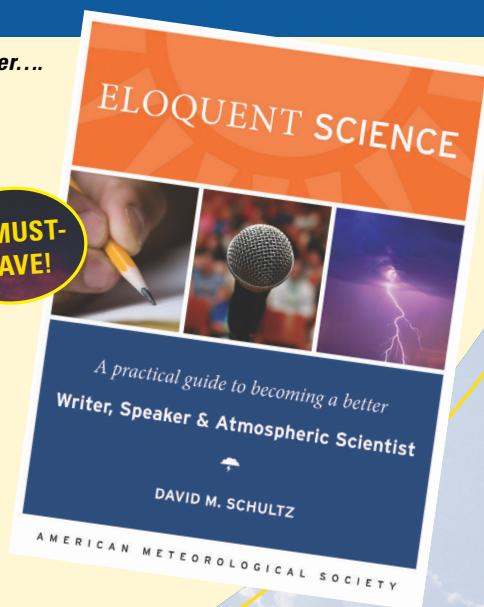
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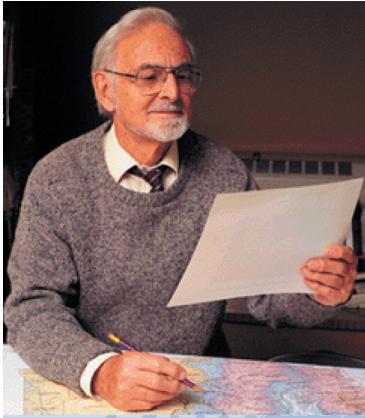
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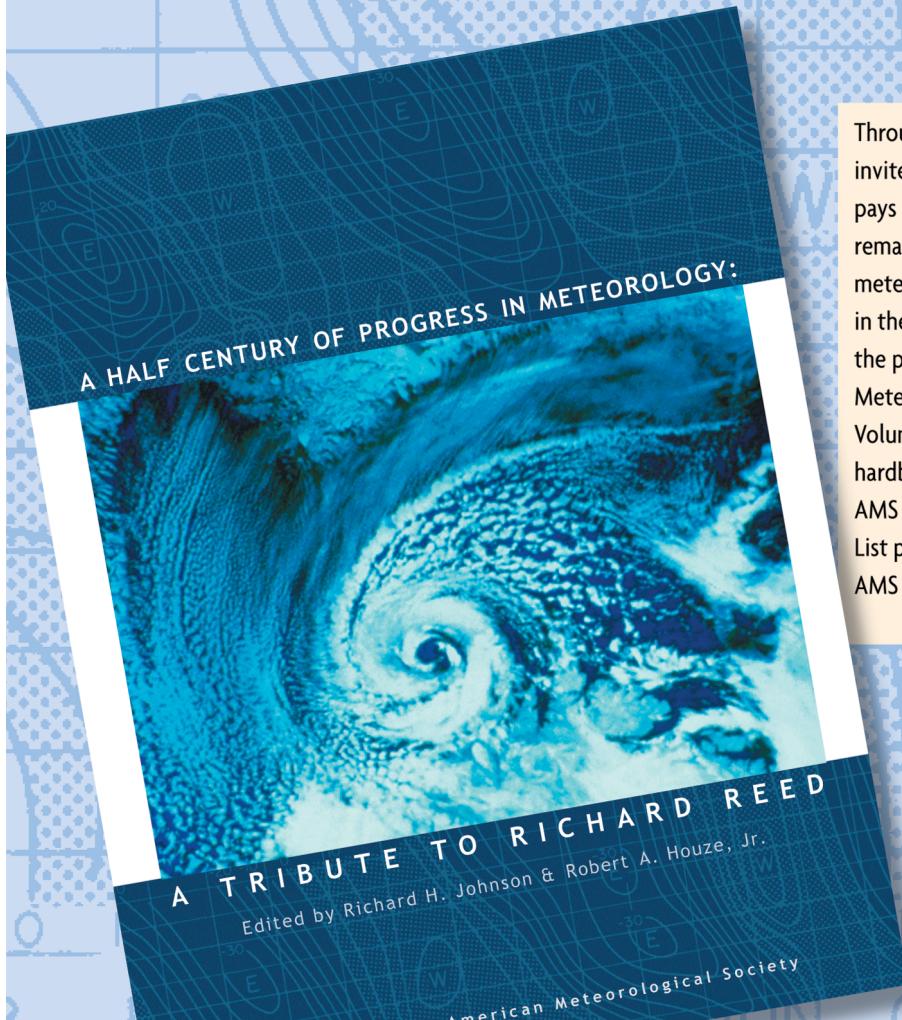
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