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A Two-week Virtual Research Experience Program for Community College Students in the Geosciences

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ABSTRACT

The Covid-19 pandemic and abrupt campus closure affected Research Experiences for Undergraduates (REUs) across the country. The Research Experience for Community College Students (RECCS) REU, based at the University of Colorado Boulder, engages community college students from across Colorado in research projects around earth and environmental topics. The RECCS program responded to this challenge by creating and implementing a novel two-week, virtual program. RECCS-Lite maintained key elements of the full REU, including an authentic research project, mentoring, a supportive cohort, and professional development, through a highly scaffolded and intentional design. Evaluative data were positive, suggesting the format offers new avenues for engaging undergraduates in research and developing STEM identity.

Key words: Undergraduate Research, Online, Community College

INTRODUCTION

The Covid-19 pandemic and abrupt college campus closures put a rapid end to most previously scheduled Research Experience for Undergraduate (REU) programs in the summer of 2020. These programs, which typically last 8-12 weeks, introduce thousands of students each summer to research, pairing them with research mentors, supporting the development of career-related skills and developing students' scientific identity. The geosciences are one of the least diverse fields of science (Bernard & Cooperdock 2018) and REUs are an effective mechanism for engaging and retaining

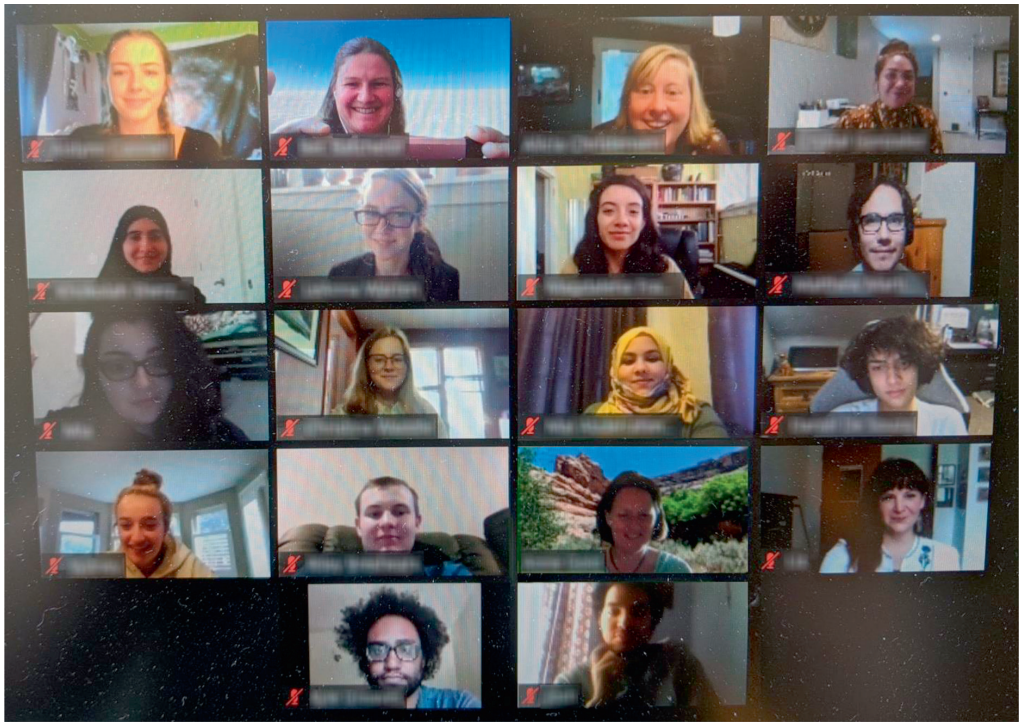

Figure 1. "Group shot" of the RECCS-Lite student researchers and RECCS team. Zoom's gallery view was fundamental for whole group discussions, while break-out rooms enabled small group discussion and think-pair-share techniques.

students, particularly those from underserved backgrounds, in Science, Technology, Engineering and Math (STEM) fields (NAS 2017). The Research Experience for Community College (RECCS) REU, based at the University of Colorado Boulder, engages community college students from across Colorado in authentic research projects around earth and environmental topics (Gold et al. 2020).

The 2020 student cohort, the most diverse in the seven years of RECCS (7 out of 14 students (50%) from underrepresented minorities including African American/Black, Hispanic/Latinx, and American Indian or Alaska Native; 10 (71%) female; 8 (57%) first-generation college students; and several in other key demographics; see Figure 1), had already been selected when the CU campus was closed for the summer. As turning the full nine-week, usually fieldwork-heavy, program virtual wasn't a good option for students or mentors, the RECCS team instead developed a highly-condensed and scaffolded two-week RECCS-Lite virtual experience to still offer a research opportunity to these students. Could this short and virtual format retain the elements of authentic mentor-led research, geoscience exposure, and a strong and supportive cohort that had previously characterized the program? Would it further develop students' scientific identity and persistence in STEM?

METHODS

Program Design

The program design followed the 5E inquiry-based learning model (Bybee et al. 2006) and was built specifically for community college students who had limited previous exposure to research. Each student was paired with a research mentor and worked on their own authentic research question. The program consisted of: i) short daily cohort-based activities; ii) one-on-one engagement with mentors; and iii) independent, asynchronous work on a research project. The intentional 5E design and instructional sequence is shown in Table 1.

Students received a weekly stipend and worked ~30 hours/week. Each student was paired with a research mentor or mentor team. These scientists identified and curated a data set that their mentee would be able to explore and work, with research subjects ranging from the "Energy Market Price Variation vs. Temperature Change in Houston, TX" to "Ocean and Atmosphere Impacts on Helheim Glacier Calving". (https://cires.colorado.edu/outreach/programs/reccs/students). Prior to the program, the RECCS team provided a virtual mentor orientation and a handbook with mentoring tips, program schedule, and daily discussion prompts for mentee meetings, and met virtually with each mentor (team) to help scope a project suitable for a two-week program. During the program, mentors met daily with their mentee and supported them in answering a (narrow) research question by analyzing the data set and creating approximately three figures, which they summarized in a scientific poster and presented in a virtual poster session at the end of the program.

Program Evaluation

The program was evaluated using three surveys administered at pre-, mid-, and post-program. The post-survey results discussed here included items from the Undergraduate Research Student Self-Assessment (URSSA 2009), as well as program-specific reflections. URSSA results were analyzed according to Weston & Laursen (2015) and open-ended reflections were aggregated and summarized according to themes of science identity, science persistence, and personal gains.

PRELIMINARY RESULTS

The RECCS-Lite program ran in June 2020. Preliminary results show that students reported above-average (Weston & Laursen 2015) gains in all four areas assessed by the URSSA (thinking like a scientist, research skills, attitudes and behaviors, personal gains related to research), though not at the same levels seen in the 9 week, in-person RECCS program. Program-specific

Table 1. Program design and agenda for two-week RECCS-Lite virtual research experience. Column headings describe the time allotted and format, daily entries describe the prompts for each day. The program was scaffolded around the 5E model (Engage, Explain, Explore, Elaborate, Evaluate). Note that times were slightly adjusted based on the specific day's schedule, though all daily cohort meetings lasted less than 75 min in total.

RECCS Lite Program Day	Cohort meeting (9:00–9:15 am)	Cohort meeting (9:15–9:45 am)	Cohort meeting (9:45–10:15 am)	Mentor meeting (~1 hour; varied times)	Asynchronous Work (~3–4 hours)
	Students *Evaluate* their learning by reflecting on research from day before *(Think-Pair-Share in breakout rooms).*	Students *Engage* in connecting to prior knowledge; begin to construct their own understandings as they actively *Explore* a concept related to that day's research activity. *(Facilitated through break-out rooms, zoom chat, and group discussions.)*	Professional Development	Students *Explain* what they are learning. Mentor solidifies concepts for the student. Mentors provided with question prompts to guide discussion.	Students complete self-guided work that mentors have suggested in order to *Elaborate* on and apply what they have learned and review resources related to poster components and research to construct and revise *Explanations*
Day 1	Cohort building, program overview, anti-harassment training, virtual lunch w/mentor, and introduction to research topic				
Day 2	How to start your research		Pathways in science, student assets	Introduction to data set	Explore data set on their own
Day 3	Relevancy of data to own life, data reflection	How to read a scientific paper	Characteristics of a scientific culture, assets, & identity	Research question & background	Read background literature, write poster introduction
Day 4	Research background reflection	Ways to analyze/ visualize data	Guest speaker: Finding your Network	Data analysis	Start data analysis
Day 5	Data analysis reflection	How to write an abstract/explain research succinctly	Similarities/ differences of scientific culture to own	Data analysis	Data analysis, write abstracts
Day 6	Data analysis reflection	How to communicate your methods	One-on-one abstract help and check in with RECCS staff	Data analysis and methods	Wrap-up data analysis, write poster methods section
Day 7	Reflect on research challenges	What to include in results/conclusion/ discussion?	Guest panel: Transfer to 4-year university and graduate school	Results, conclusion, discussion	Add results, figures to poster, write conclusion and discussion
Day 8	Results/conclusions/discussion reflection & assistance		Guest panel: Careers in the geosciences	Conclusions/ discussion	Refine results, conclusion, discussion
Day 9	Reflection on what has been learned during program	Poster writing assistance	Scientific culture and using assets	Practice presentation with mentor	Refine poster, practice presentation
Day 10	Students present their posters to mentors, friends/family, RECCS staff				

questions showed that the daily cohort engagements, with their identity-focused reflections, use of Zoom breakout sessions to allow small groups of students to interact, and professional development offerings, helped to build a sense of community. Survey reflections also showed that one-on-one meetings with program staff and mentors helped students feel connected and supported, and external panelists provided valuable insight toward thriving in college, graduate school, and careers. The authentic but limited research experience provided a rapid confidence burst as students survived a steep learning curve (in some cases learning new tools, such as Excel, R and Python along the way) to successfully analyze data and present their posters in a live-stream accessible to their mentors, friends and family. After participating, 10 students described the program as directly influencing their intent to proceed in STEM fields and/or pursue a graduate degree. Sample quotes include:

"I had definitely never considered attempting to obtain a PhD and [my mentor's] openness and willingness to share her experience was extremely eye opening and helped me to see that pursuit as an actual option."

"I think RECCS really gave me an amazing opportunity to learn and adapt. I think many doors will open for me because of this program. "

"I am more confident in what I want. I loved this time and this experience. It was fun and interesting. I am going to keep connecting and work hard."

"I'm also floored by the amount of support from my cohort and that we were actually able to connect and make friendships virtually."

Feedback from students and mentors regarding the format was generally very positive, though most expressed that they would have liked more time on their research. While some projects did require modification of datasets and expectations due to the limited timeframe, and in future we might recommend sticking to a single data-analysis tool and providing training in its use, the presented posters were of high quality and compared well to posters developed in previous RECCS programs. Most students showed advanced understanding of their research topic and findings during Q&A. We attribute the fact that students were able to move from novice to presenting and discussing their research findings within just two weeks to the effective and widely tested format of the 5E instructional model, combined with the significant commitment of the program mentors. In-depth data analysis will explore this question further.

NEXT STEPS

The two-week RECCS-Lite virtual format turned out to be an effective means of engaging community college students in research and seeding the development of their scientific identity. Beyond the pandemic, this two-week virtual format has the potential to provide new avenues for students that might not have engaged in a full-summer REU program, including those with family and work responsibilities, students who live in remote places or are tied to their community, and students with disabilities. Further, the format is not only significantly less expensive than a residential REU, but also a more manageable format for mentors who might not be able to mentor for a whole summer due to field work or other commitments. We are excited to explore this format in the future with community college faculty who are interested in incorporating the model within their classes, and with rural and tribal communities who are often not reached by research experiences. The format additionally lends itself to a wide range of STEM disciplines and could be easily adapted for high school or academically more advanced students as a way to meaningfully connect students with 4-year college faculty or national lab scientists and provide REU-like gains in scientific identity and STEM retention.

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REFERENCES

Bernard, Rachel E., and Emily H.G. Cooperdock. "No progress on diversity in 40 years." Nature Geoscience 11, no. 5 (2018): 292–295. https://www.nature.com/articles/s41561-018-0116-6/

Bybee, Rodger W., Joseph A. Taylor, April Gardner, Pamela Van Scotter, J. Carlson Powell, Anne Westbrook, and Nancy Landes. "The BSCS 5E instructional model: Origins and effectiveness." Colorado Springs, Co: BSCS 5 (2006): 88–98. https://media.bscs.org/bscsmw/5es/bscs_5e_executive_summary.pdf

Gold, A.U., Okochi, C., Briggs, J., Smith, L., Atkin, R., McNeal, K., Curry, R.C. "Increasing Community College Students' Interest and Preparedness in the Sciences Five years of data from a summer research experience program for community college students at a four-year research university" Journal of Geoscience Education (in review).

National Academies of Sciences, Engineering, and Medicine. "Undergraduate research experiences for STEM students: Successes, Challenges, and Opportunities" (2017). https://www.nap.edu/catalog/24622/undergraduate-research-experiences-for-stem-students-successes-challenges-and-opportunities

Weston, T. J., & Laursen, S. L. "The Undergraduate Research Student Self-Assessment (URSSA): Validation for use in program evaluation". *CBE-Life Sciences Education*, (2015) *14*(3). http://www.lifescied.org/content/14/3/ar33.full

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