Remote Early Research Experiences for Undergraduate Students in Computing

Cecilia O. Alm
coagla@rit.edu

Reynold Bailey
rjb@cs.rit.edu

Hannah Miller
hm@mail.rit.edu

Rochester Institute of Technology

ABSTRACT

We provide an experience report about a remote framework for early undergraduate research experiences, which was thematically focused on sensing humans computationally. The framework included three complementary components. First, students experienced a team-based research cycle online, spanning formulating research questions, conducting literature review, performing fully remote human subject data collection experiments and data processing, analyzing and making inference over acquired data with computational experimentation, and disseminating findings. Second, the virtual program offered a set of professional development activities targeted to developing skills and knowledge for graduate school and research career trajectories. Third, it offered interactional and cohort-networking programming for community-building. We discuss not only the unique challenges of the virtual format and the steps put in place to address them but also the opportunities that being online afforded to innovate undergraduate research training remotely. We evaluate the remote training intervention through the organizing team's post-program reflection and the students' perceptions conveyed in exit interviews and a mid-program focus group. In addition to outlining lessons learned about more or less successful framework elements, we offer recommendations for applying the framework at other institutions as well as how to transfer activities to in-person formats.

CCS CONCEPTS

• **Applied computing → Interactive learning environments**.

KEYWORDS

virtual, online, remote, undergraduate research, research experience for undergraduates, REU

ACM Reference Format:
Cecilia O. Alm, Reynold Bailey, and Hannah Miller. 2022. Remote Early Research Experiences for Undergraduate Students in Computing. In *Proceedings of the 53rd ACM Technical Symposium on Computer Science Education V. 1 (SIGCSE 2022), March 3–5, 2022, Providence, RI, USA.* ACM, New York, NY, USA, 7 pages. https://doi.org/10.1145/3478431.3499283

SIGCSE 2022, March 3–5, 2022, Providence, RI, USA

ACM ISBN 978-1-4503-9070-5/22/03…$15.00
https://doi.org/10.1145/3478431.3499283

1 INTRODUCTION

The COVID-19 pandemic enforced the need for innovation and rapid prototyping of strategies for the delivery of undergraduate research experiences in computer science and other STEM disciplines. We provide a comprehensive experience report on the migration of cohort-based mentored research for undergraduate students which took place during 10 weeks in summer 2021.

The focus of this program remained, as in its previous years, on team science-based projects which involved human-sensing technologies and human considerations in the use of AI systems, augmented with professional development activities aimed to nurture research skills and to coach students toward potential graduate study and careers as computational researchers. Moving activities online involved addressing several challenges–from time zone differences for arranging research meetings and programmatic cohort activities, via the core technical challenge of conducting remote research with human subjects and collecting sensing data with webcams rather than specialized sensing hardware in the lab, to Zoom fatigue and attempting to create meaningful interactional encounters for cohort networking and team-building without being face-to-face, as well as keeping students engaged as teams to ensure mental self-care and persistence in the remote setting.

Our contribution centers on (1) providing a springboard for remote research experiences in computing by discussing more versus less successful elements based on both student perceptions collected in exit interviews and a mid-term focus group and organizers' reflections, (2) recommending how to generalize the lessons learned to other institutions, research themes, or in-person settings, and (3) discussing potential improvements.

2 SELECTED RELATED WORK

We discuss the theoretical concepts that form the basis for the design of this research experience for undergraduates (REU) program and the prior literature on mentored research experiences for undergraduate students. We especially report on findings from recent reports on virtual research or research-like experiences and how these reports aligned with or shaped this REU program.

2.1 Theoretical Framing

We framed the design of this REU training program within the theory of cognitive apprenticeship [9, 17], through the lens of Social Cognitive Career Theory (SCCT) [3, 22], and around the coaching of students toward potential research careers. Using a team science perspective and attending to menteeship development [2], the program emphasized mentoring over supervision [8].

In the design of this virtual research experience, we also considered the documented value in the training and mentoring literature of offering opportunities for the students to experience near-peer mentoring [1, 32, 42], considering especially the benefits noted for underrepresented students [39]. Thus, we offered elements led by a PhD student (e.g., a journal club and a technical office hour) and interactions with additional PhD students, including a mentoring café and an interdisciplinary Graduate Study and Research Symposium. Additionally, Ross et al. [34] discussed recruiting underrepresented students for research in computer science education and reported that community building and discussions with current STEM PhD students were program highlights; our REU also included community building besides near-peer mentoring.

2.2 Mentored Undergraduate Research

Lunsford et al. [25] reviewed a decade of work on mentoring in higher education, noting that "[o]verall, findings point to mentoring as a means of directly or indirectly improving academic outcomes, such as grade point average and persistence in higher education (Bordes-Edgar et al., 2011; Campbell and Campbell, 2007; Crisp, 2011)" (pp. 317-318). Furthermore, quoting from the same study:

> *Mentoring positively influences student outcomes such as:*
> - *sense of belonging (O'Brien et al., 2012),*
> - *capacity for socially responsible leadership (Campbell et al., 2012),*
> - *deep and strategic learning approaches (Chester et al., 2013), and*
> - *self-confidence in professional skills and abilities (Thiry et al., 2011).*
>
> (Lunsford et al. [25], p. 318)

In addition, Eagan et al. [12] noted that both faculty and graduate student interactions positively influenced graduate school pursuits. Levin and Grewe [23] encouraged mentors to consider how the goals, values, culture, and etiquette of a physical lab transfer to an online setting. They also highlighted the opportunity that distance research can present for engaging individuals who may not be able to conduct research in-person (e.g., parents of young children).

2.3 Virtual Undergraduate Research or Research-like Experiences in STEM

While STEM literature about undergraduate remote research is present, the computing-specific literature on this topic is sparse.

Both Speer et al. [35] and Qiang et al. [30] discussed mentoring challenges in basic STEM contexts where the lab is at the heart of the research. Speer et al. [35] surveyed undergraduate mentees or graduate, near-peer mentors. Despite contextual differences for their and our participants (computational research does not involve wet lab work, etc.), there were several relevant insights. First, while most respondents felt less productive, having the mentoring online neither dissuaded undergraduates from future STEM pursuits nor graduate students from mentoring in the future. Second, while a bit more mentoring reportedly occurred by email, the video-conference format was deemed by the majority as a preferred communication method. Video conference tools can bring mentoring closer to in-person, while mentoring from home also adds an informal touch. Third, the online format still strengthened bonds and enabled mentee-mentors to get to know each another and be cognizant of each other's well-being. Their study reassured that virtual mentoring can be mutually beneficial, and reaffirmed it can improve inclusion. Focusing on chemistry, Qiang et al. [30] highlighted activities related to chemistry research that can be carried out from home, including enhancing skills in using computational methods or resources—a reminder that computational research experiences such as the one discussed here can be quite feasible virtually, although our REU also could not include wearable sensing hardware in our user studies, which had to be limited only to the webcam format. The authors noted that they "utilized this opportunity to teach the students that rapid changing (or even totally expected) situations sometimes can happen during their professional career, so they have to be able to adapt accordingly and quickly" (p. 3447).

Hung and Proctor [18] surveyed faculty in a psychology research course. For the abrupt transition to a remote environment, faculty reported struggles such as slower research progress, student mental health concerns, and student disengagement. From a student perspective, such challenges can have long-term consequences. In particular, Speer et al. [35] remind that research experiences that are not positive can result in attrition. In contrast, we were able to plan remote activities in advance, and we hosted a faculty mentoring roundtable with discussion of the program logistics prior to the start of the program to review and discuss strategies and best practices for undergraduate research mentoring in general and specific considerations for online mentoring.

Fey et al. [13] studied remote research in two ecology and environmental science courses at an undergraduate college. From a survey, they identified four themes; three were positive (e.g., students were able to adapt to the difficulties of working remotely), and one was negative (some students struggled with distance work). Challenges included no access to physical labs and unequal student access to consistent housing, internet, etc. Despite the challenges, among their theme-based findings were that "[e]xperience working in remote teams is relevant to career aspirations" (p. 12534) and "[s]tudents can gain identifiable, valuable skills in conducting remote, collaborative work" (p. 12535). In this REU, we focused on team-science research projects.

Fuse et al. [15], focusing on STEM areas at a liberal arts college, noted that online undergraduate research experiences enabled "much more deliberate growth in [students'] time management skills and skills as independent researchers who take ownership of their work." (p. 77), highlighting that the remote format also enabled new opportunities. Mechanisms for addressing challenges included virtual seminars on developing skills for research, using time-keeping as well as collaboration tools, including Slack. Our REU also offered seminars and workshops, and we recommended a time-tracking tool. Another successful element was digital lab notebooks; our REU encouraged students to keep daily research notes.

Parrington and Giardino [29] gave nine recommendations for remote REUs in biological research, and our REU adapted almost all of these recommendations, including twice-weekly team meetings with the faculty mentors, presentations on research, workshops for professional development, journal club readings, opportunities for networking, and dissemination of the participants' research.

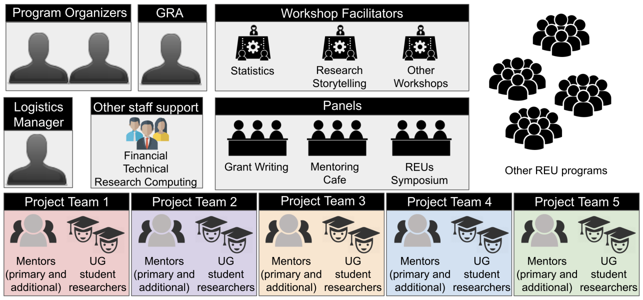

Figure 1: Overview of the organizational structure and people in the remote undergraduate research experience.

3 DESIGN OF THE REMOTE EXPERIENCE

3.1 Administrative Overview

The REU's foundation was five team-based research projects, each involving a pair of undergraduate researchers whose activities were guided by a primary and two secondary mentors (Figure 1). The program logistics and professional development and team-building activities were coordinated by two program organizers and a graduate research assistant (GRA). The research fields of the participating faculty were computing, engineering, and liberal arts. A logistics manager focused on coordinating financial tasks and sending weekly reminders of upcoming programming. Workshop facilitators prepared and delivered workshops. Panels were also used.

The REU program coordinated two activities with similar programs across STEM disciplines. These included a Graduate Study and Research Symposium and fortnightly student-led social events. We also adopted a T-shirt design exercise from another program. At the end of the summer, students presented research at a virtual university-organized undergraduate research symposium. Lastly, additional people involved were college or department administrators who gave event remarks, external researchers who assessed student lightning talks and achievement talks at the beginning vs the end of the program, and university staff who supported IT, etc.

3.2 Participants

The remote research experience engaged ten US undergraduate students selected from among a diverse pool of close to 260 applicants. Cohort demographics included 90% from outside the host institution, 90% computing majors (computer science or a computer science-related field), 50% from institutions with limited access to research opportunities in computing, 70% women, 30% from years earlier than college junior (at time of application), 60% AALANA (African American, Latino/a American, or Native American), and 30% experiencing a disability. The students participated in the experience virtually from four United States time zones (Figure 2).

Pairs of students worked on five different research projects under the overarching theme of computational human sensing and its intersection with AI. Each project was supervised by a faculty mentoring team comprised of a primary mentor and at least two additional mentors. Teams typically met twice weekly via Zoom to

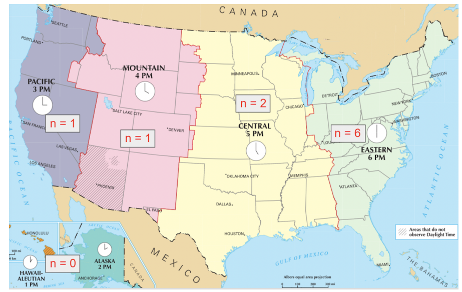

Figure 2: Time zones of the undergraduate researchers.[1]

review progress, address challenges, and outline next steps. Additionally, the cohort of students participated in a variety of skills-building programmatic activities (Table 2). As this was a full-time paid research experience, students worked during regular business hours, 8 hours per day, Monday through Friday with meetings and programmatic activities scheduled during the overlap of their working hours to accommodate the different time zones, i.e., mostly scheduled between 12pm and 5pm US Eastern time.

3.3 Pre-program Identification of Challenges

Before the program started, we conducted literature review on virtual experiences and shared these in a summary handout with mentoring faculty at a virtual mentors' roundtable. Organizers also brainstormed anticipated challenges with offering the program in an online format and identified solutions (Table 1).

4 TEAM-SCIENCE RESEARCH EXPERIENCE

4.1 Organizational Tools

For organizing the remote REU, we used several tools with online remote access: Zoom for virtual video-conference meetings, a centralized REU Google calendar which contained all Zoom links, Slack with various channels, and Miro Boards for brainstorming or Q&A sessions.[2] Each team had a Google Drive as well as a team account and shared disk space and software resources on our institution's research computing server. We recommended that teams use Toggl for time-tracking, and we instructed students to keep an individual notebook/log in their team drive to reflect on their daily activities. We used a private Instagram account to share screenshots from key events including student talks.

Our Slack space included five team-specific channels, a student channel for interaction between students and between students and organizers, a student-and-faculty (general) channel mostly used for announcements, a journal club channel where the students posted responses for the weekly paper readings, and a positive-sharing channel for posting pictures, etc. The Slack also had channels for organizers, for mentors, and for the organizers plus the GRA. Everyone had access to direct messaging.

4.2 Near-peer Mentoring

Prior research has noted the benefits of near-peer mentoring interactions (Section 2.1). Undergraduate students may feel more comfortable asking questions about doctoral studies, socializing

[1] Image adapted from https://commons.wikimedia.org/wiki/File:US-Timezones.svg

[2] Our institution provided access to enterprise versions of certain tools (e.g., Slack).

Table 1: Identified challenges with an online research experience program and the corresponding implemented solutions.

Identified Challenges	Implemented Solutions
Data-processing challenges	Used software that was either open-source or had direct support
Limited opportunity for nurturing team dynamics	Used board app for brainstorming/Q&A in sessions, panels
Limited within-team and cross-teams interaction	Student, faculty-student, and 5 team-specific Slack channels
Loss of formal/informal face-to-face interaction	Online intra-cohort team-building/inter-cohort socials
No lab-based computing resources for research	Arranged remote research computing resources
No specialized equipment for human subjects experiments	Used webcam- and survey-based remote data collection
No STEM outreach event	Encouraged sharing at home institution post-program
Staying on track/time-management from home	Encouraged teams' use of a time-management app
Time-zone challenges	Cohort and team sessions mostly within 12pm-5pm EST
Unable to involve any students from abroad (time-zone)	Still involved research talk evaluators based abroad
Zoom fatigue and mental health	Meetings/sessions part-day; positive sharing Slack channel

Table 2: Rough weekly schedule for in-program logistics, professional development, and evaluation. Research project-specific activities (team meetings, data collection, processing, analysis, etc.) are not included. RCR = Responsible Conduct of Research; T2M = Teaching-to-Mentoring talks by faculty about their research areas; GSRS = Graduate Study & Research Symposium.

Wk	Logistics/Evaluation	Dissemination	Professional Dev. (Workshops/Seminars)	Socialization	Near-Peer
1	Entry interv., RCR		Orientation, T2M, IRB & sensing workshops	Minecraft	
2	IRB application		T2M, Research Computing 1	REUs social	Journal club
3	Exp. summary and discussion	Lightning talk	Research Computing 2	T-shirt design	Journal club
4	Mentor report 1		Grant writing 1, R Statistics 1, PhD director	REUs social	Journal club
5	Focus group		Grant writing 2, R Statistics 2	Escape room	Journal club
6		Interim tech report	Grant writing 3, Research stories retreat	REUs social	J. club; GSRS
7	Mentor report 2				Mentoring café
8		Project visual		REUs social	
9		Achievement talk			Alumni celeb.
10	Mentor report 3 Exit interview	UG Research Symp Final technical report		End-of-program virtual celebration	

with, or resolving low-level technical challenges through interactions with a graduate student. For 10 hours/week, a PhD student participated as a graduate research assistant (GRA). We engaged the GRA two weeks before the REU started with a logistical meeting and a pre-program meeting to discuss the GRA's responsibilities. The GRA led an online mentoring café event (Section 5.3), a recurring journal club (Section 5.5), and team-building activities (Section 6). The GRA held a daily technical consultation hour to help students with topics ranging from Unix commands and remote server login to Python package installation. This ensured that students' technical issues were resolved and did not block their progress until their next meeting with their faculty mentor. These daily consultations were in the late afternoon to accommodate all time zones.

5 PROFESSIONAL DEVELOPMENT

5.1 Online Workshops and Seminars

Structure. The research experience held workshops and seminars designed to build technical skills and to increase awareness toward graduate school and research careers. Before the REU, each student completed human subjects research training and a Python programming course. During the REU's first two weeks, each faculty mentor gave a 30-minute talk about their research focus and highlighted a wide variety of pathways to a research career.

Since each team project included collection and analysis of human-sensing data, the program required participation in an IRB workshop. Early workshops included a tutorial on the university's research computing cluster and a multi-session grant writing seminar. As teams neared the end of their data collection, two hands-on workshops covered statistical analysis in R. Another workshop about research storytelling aimed to engage students in peer review and discussion of interim reports, overview of professional peer review and various categories of publications, technical writing tips, etc. As shown in Table 2, the REU front-loaded the professional development activities to enable the last weeks being more fully dedicated to research and associated dissemination. Workshops took place on Zoom with experienced facilitators.

Generalizability and Resource Needs. The workshops and seminars can be used in other institutional contexts including in-person. The key resource is the availability of facilitators with expertise.

Reflection. Students struggled with technical workshops that introduced concepts before they were used in the research process.

5.2 Graduate Study and Research Symposium

Structure. We led a collaborative symposium event attended by students from five programs representing different STEM disciplines, including a program at a nearby university. The event was structured as a webinar to facilitate participation by a large audience with pre-event registration and an auto-reminder. The format ensured that undergraduate student attendees were not in view, while enabling moderators and speakers to share their webcams, microphones, and screens. The webinar also enabled the ASL interpreters to conduct their work clearly in view and the attendees to clearly see captionists typing, since only the current speakers were shown. The symposium began with opening remarks by the provost, followed by four sessions: two sessions with two 20-minute research talks by PhD students from four disciplines, who also served as panelists on two 30-minute panel sessions about graduate school topics. There was a break mid-way. We used Zoom's built-in webinar Q&A functionality for students to ask questions of the panelists.

Generalizability and Resource Needs. For undergraduate-only institutions, this event requires a partnership with PhD programs. There were no costs; even the event program was distributed digitally. For an in-person event, catering costs should be added.

Reflection. Especially the panels elicited much interaction with undergraduate attendees. We were unable to get through all questions in one panel so panelists continued to answer questions using the written Q&A feature. If in-person, the event would have been longer with a coffee break, luncheon, and a plenary. Still, 3 hours was long on Zoom, and the event could be shorter with fewer talks.

5.3 Remote Mentoring Café

Structure. For the mentoring café, the REU students met informally with four PhD students about graduate school. The REU students were assigned to breakout rooms, and each PhD student spent 15-20 min. per group. Then, the PhD student rotated to the next group. The REU students prepared their own questions in advance. Questions from the earlier symposium were used as prompts.

Generalizability and Resource Needs. This event can be transferred to other contexts. For undergraduate-only institutions, the event requires a partnership with a PhD program. Like the symposium, the in-person event would have refreshments.

Reflection. This event worked well for the undergraduate students and the PhD students. It also worked equally well remotely, as previously in-person.

5.4 Virtual Alumni Celebration

Structure. To encourage interaction across cohorts and provide an opportunity for additional networking, the participating students attended the program's 5-year alumni celebration. Following welcome remarks from the dean, chair, and program organizers, organizers shared a slideshow of pictures that encouraged alumni to informally reflect on their experiences and to describe accomplishments since completing the program. The GRA led the attendees in a fun trivia game. As scores were tallied, attendees were split into breakout rooms to promote discussions and mingling between current and former students. Returning from the breakout room, the alumni winners of the trivia event were announced (each received a T-shirt designed by the REU students), and alumni were encouraged to provide contact information via a web form.

Generalizability and Resource Needs. The remote format worked well and enabled participation of more alumni at low cost.

Reflection. The event was held after teams presented achievement talks but were still working toward their final deliverables. The sentiments expressed by the alumni and their accomplishments could serve as an encouragement to persevere in final weeks.

5.5 Online Journal Club

Structure. Journal clubs train students in reading, understanding, and presenting the current literature [20, 33]. For five weeks, the REU cohort met in Zoom for a 45-minute discussion on an assigned paper related to the research project of one of the five teams [11, 19, 21, 31, 38]. The GRA chose the paper, assigned sections to each team, and provided supplemental links, including video materials [14, 26, 27, 36, 40, 41]. The team whose research was most closely related to the paper was assigned to the Results and/or Discussion sections, and the remaining teams were rotated among the other sections. The rotation of section assignments promoted discussion since every team had a section to present at each meeting.

Each week, all students read the paper and posted on Slack a 2-3 paragraph technical commentary, 2-4 bullet points specific to the assigned section, and a 2-3 sentence summary. The bullet points were put in a shared slide deck, displayed in the meeting. The GRA moderated the lively discussion. Glazer [16] writes about the importance of journal clubs to keep up-to-date with the recent literature while not doing all of the reading on one's own. Glazer's students individually chose, read, outlined, and presented a paper; here we used an interwoven approach with each team focusing on a specific section and spending a few minutes on informal discussion with their peers. Li and St Jean [24] found that journal clubs (even virtual ones) increase technical skills while decreasing stress.

Generalizability and Resource Needs. This activity is compatible with other institutional contexts. Library resources suffice.

Reflection. By stimulating reading, writing, and preparation in advance of discussion, the journal club sought to provide an interactive environment for students to learn how to read and discuss scholarly work in presented and written form and to build this knowledge into their own reading of research papers. The students appreciated the extra video materials. They reviewed fewer supplemental links as their project duties expanded over the weeks.

6 TEAM-BUILDING ACTIVITIES

Structure. To address the lack of informal face-to-face interaction experienced in a lab and on-campus context (e.g., shared meals), we scheduled team-building and socializing activities for the students. These included a Minecraft campus tour, a T-shirt design, a free virtual escape room, and biweekly online social events with students from similar STEM programs. The activities were spaced out across week 1 to week 8 (Table 2). A end-of-program celebration on our last day recognized student achievements and enabled interactions.

Generalizability and Resource Needs. Most activities generalize well to remote or in-person environments. Not every campus will have a Minecraft version, but in a virtual context, students could use a campus map to find landmark locations while competing against other teams for time. In-person options include a campus tour or a photo scavenger hunt. The T-shirt design activity can be done in any context. The virtual escape room could be done in-person.

7 DISCUSSION: LESSONS LEARNED

We include organizers' reflection on what worked (+) and remaining issues for improvement (-). Similarly, we discuss identified themes from rich qualitative interviews and focus group feedback from the students. Student participants (n = 10) consented to data collection, which was approved by the Institutional Review Board.

Organizers' reflections. Key positive/negative observations are:

+ Team-based mentoring functioned well and positive mentoring relationships were formed. The mentoring roundtable may have supported faculty's preparation. All teams completed their dissemination deliverables (Table 2) and identified relevant professional peer-reviewed venues and scheduled post-program meetings to continue working toward external dissemination.
+ Students were highly engaged in research projects and attended all professional development and team-building activities.
+ Logistical arrangements for team meetings and events across different time zones mostly functioned well. The cross-cohort alumni event was an energizing element. There was upper-level administrative support, and excellent access services support.
+ Interactive programming tended to work better than lecture-style in the remote format although the shorter talks by faculty went well, and sessions with preparatory elements before the session also benefited the interaction.
- The remote human-sensing data capture resulted in technical issues (e.g., data loss due to internet bandwidth, and noisy data related to non-ideal capture conditions such as poor lightning or webcam occlusion). Scheduled subjects appeared more likely to be no-shows in the remote setting, and this issue particularly impacted one project that required pairs of participants.
- Although team-building clearly occurred within teams, it was less prominent across teams although cross-team interactions were encouraged. Beyond Slack and Zoom, students rarely took advantage of other collaboration tools such as Trello, which may indicate a saturation point for virtual tools to manage.

Exit interviews. Main thematic observations include:

+ Many students appreciated the interactive journal clubs. (In their final technical reports, several teams cited at least one paper read in the journal club.) A few students even planned to bring this format back to their home institution.
+ Students enjoyed PhD student interactions, in particular in the mentoring café. They also felt that the online resources provided (tools, software, and computing, etc.) were good.
+ Students felt they met objectives they set themselves in early entry interviews. Nonetheless, two students who set a goal to form deeper connections and a dependable network felt this was difficult to achieve remotely.
+ The structure of the REU and paired students on team-based projects with mentors appeared appreciated, and students spoke highly of the mentors.
+/- Some students appreciated the team-building, social activities, and workshops, while others felt they did not work well in the remote format. One student mentioned the socializing events "did the most they could with being online." The most technical workshops were less liked, but this could reflect the trade-off between the time allotted in trying to avoid overly lengthy sessions and the depth of the technical content.

While conducted mid-term, before students had completed the second half of the program, the student focus group revealed, for example, that the autonomy students experienced in a research project was perceived as positive, although students acknowledged that the transition to mentoring and increased independence was demanding. This seemed exacerbated by the virtual format requiring self-discipline to maintain 'business hours.' The issues with conducting human subject studies online appeared to have impacted students' impression. Students also expressed a wish for either more programming or less. The diversity in the cohort was appreciated, and the faculty talk series at the beginning allowed students to see that professional journeys of faculty differ.

For the negative observations and suggested improvements, we recommend that virtual research experiences: (1) emphasize interactivity in programming; (2) revisit technical workshops with a refresher session; (3) discuss directly the different opportunities and challenges in controlled lab-based data collection, virtual data collection, and other scenarios such as fieldwork; (4) identify practical tips (e.g., internet bandwidth tests in human subjects sessions) for virtual tasks; and (5) encourage virtual meeting efficiency (agenda, minutes, etc.) and enforce the use of a project management tool such as Trello for team note-sharing and action-item tracking as well as use of formal time-tracking–with reassurance that breaks are vital. We also learned that several elements worked well also in the remote scenario such as the faculty talk series, the mentoring café, team-science mentored research, and we saw that a journal club can work well remotely. The alumni celebration was even enabled by the remote format, and conducting research remotely resulted in less travel-related environmental impact. In addition, it was useful and logistically lean to provide a central shared calendar with all meetings and Zoom links. The use of Slack for timely communication, sharing announcements, and facilitating group, team, and small group interaction, including for informal sharing, was also logistically successful. Nevertheless, overcoming the challenge with nurturing virtual social interaction, team-building, and networking outside one's immediate research team remains challenging.

8 CONCLUSION

In this experience report, we detailed a remote research experiences for undergraduates 10-week program, highlighting lessons learned and recommendations for improvements. In addition, we outlined the resources needed to generalize the programming to other institutional contexts. A limitation of this work is the small sample size. Future work could also study the longer-term outcomes of the early research experience. This paper adds to the sparse prior work on remote REUs in the computing and information sciences.

ACKNOWLEDGMENTS

This material is based upon work supported by the National Science Foundation under Award No. IIS-1851591. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

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