OTHER FEATURE ARTICLE

Positioning Humanity before Progress: Students' and Mentors' Perceptions of the COVID-19 Impact on Undergraduate Research

Miloš Savić, Naga Rama Kothapalli, *University of Oklahoma*
Hayley C. Lanier, Erin K. Freeman, *University of Oklahoma*
Lisa Ratliff, Emma Hillermann, Courtney Martin, *University of Oklahoma*

Abstract

One of the most important actions in research and mentoring is to adjust expectations and provide emotional support when unexpected events occur. In this article, the authors investigate the impacts of COVID-19-based campus closures on undergraduate research and the student and faculty impressions of the adjustment. Through interviews with 28 students and 17 mentors from a campus-wide undergraduate research program, common themes in the responses to COVID-related impacts were found. Students had to adjust to the type or scope of their research obligations while handling academic responsibilities, and mentors explicitly considered students' well-being above expectations related to research. Providing professional development to mentors that emphasizes flexibility and compassion in the mentor-student relationship is recommended.

Keywords: *COVID-19, disaster, empathy, mentorship, undergraduate research*

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Similar to many higher education institutions worldwide (Grimm 2020), the University of Oklahoma (OU) closed nearly all activities in March 2020 due to the COVID-19 pandemic. One activity directly affected by this closure was undergraduate research, with the initial closure halting or shifting undergraduate research plans and the later reopening providing its own limitations due to restrictions on undergraduates' campus presence. As a result, both faculty and students were forced to change their usual research protocols and create alternative plans, often having to pivot from a face-to-face research mentoring relationship to one that existed solely through virtual interactions. Although previous research has suggested that virtual mentorship can provide some of the same benefits of face-to-face mentorship such as social and academic support as well as some other benefits not provided by face-to-face mentorship such as increased flexibility (Owen 2015), members of the mentoring relationship often need time and training to obtain these benefits (Ensher, Heun, and Blanchard 2003). Given the abrupt nature of COVID-19 campus shutdowns, neither faculty nor students had time to prepare for this switch to virtual mentoring, giving rise to several unforeseen challenges such as ways to continue a research program that relies on in-person data collection, interaction with on-campus research labs, and methods to handle differences in time zones and differential access to technology. Although common in community-wide disasters (Smith, Drefus, and Hersch 2011), these unexpected challenges to routine have been related to increased anxiety (Cénat et al. 2020), feelings of uncertainty (Smith, Drefus, and Hersch 2011), and decreased functioning (Zisberg et al. 2007) while providing those affected with opportunities to make innovative changes in an effort to meet goals (Magni et al. 2013).

In light of the many effects of these challenges, the authors were interested in how students and faculty mentors perceived the effects of COVID-19 on their undergraduate research programs, especially since previous research has demonstrated time and again that participation in undergraduate research can have incredibly positive effects for students (e.g., Kendricks et al. 2019). To this end, a series

of qualitative interviews were conducted with participants of OU's Four-Year Research Engagement (FYRE) program in which the effects of these changes on undergraduate researchers were evaluated, the impacts of COVID-19 on supporting undergraduate research and undergraduate students were assessed, and the psychological implications of those impacts were discussed. The results suggest that COVID-19 necessitated innovative and humanistic adjustments by both mentors and students to ensure successful and continued collaboration. Particularly, the mentors made adjustments that are similar to best mentoring practices such as balancing rigorous expectations for research with emotional support and appropriate personal interest in students' well-being (Shanahan et al. 2015).

Background: FYRE Program

The NSF-funded FYRE program supports the intellectual and career development of undergraduate researchers. As the *de facto* campus-wide interdisciplinary STEM development program, FYRE matches students with faculty mentors to conduct cutting-edge research across 16 STEM departments at OU. With the goals of providing an immersive research experience and building a community of undergraduate researchers, the FYRE program serves approximately 80 students per year. Although undergraduate participants are primarily first-year students interested in research, the FYRE program also provides a tiered curricular opportunity to students to incorporate research and professional development with course-credits toward degree completion. As part of students' research participation, they are expected to devote 10–12 hours per week to research-related activities and present their work at the end-of-semester public poster presentation. To supplement those experiences and build community, students meet as a group for biweekly information sessions to discuss scientific ethics and science news as well as learn about various STEM careers (Kothapalli 2018).

After spring break of 2020, and with little notice, all non-COVID-19 research laboratories closed, and OU moved its entire instructional component online. The shift from in-person meeting about STEM careers to an online format was smooth, but the transition of the research component to distance interactions varied. During the transition, FYRE program administrators created guidelines for faculty mentors and provided students with a list of instructions for the remainder of their semester. There were numerous discussions about poster preparation and presentation (atypical for a regular semester) conducted via emails and Zoom sessions. Despite the curtailed semester, the poster session was still hosted virtually to allow the students to demonstrate their progress in their scientific understanding as well as the impact of their contributions. To show the breadth of the topics where the FYRE students were engaged in research, a sample of research areas and the titles of posters presented are shown in Table 1.

To examine the impact of COVID-19 shutdowns on student research, research participation was classified into six categories using student project descriptions (see Table 2). Five out of every six FYRE students shifted their research, conducted a literature review, did not have guidance, or did not complete a project. These effects of the COVID-19 shutdowns added to the authors' curiosity about the ways such a large disruption in undergraduate research were addressed by students and mentors.

Methods

To understand how faculty and students worked together to address disruptions caused by COVID-19, a series of semi-structured interviews with FYRE students and mentors were held. All recruitment, consent, and interview protocols were approved by OU's IRB process (#12003). These participants self-selected via an email sent out by the administrator (an author) that had a link to scheduling an interview. Three undergraduate students (all authors) interviewed 28 FYRE participants, all of whom were STEM students. There was an opportunity for students to identify gender and race/ethnicity during the interview: there were 14 women, 12 men, and two who did not state their gender; as well as 20 White/Caucasian students, four Asian students (Chinese, Indian, Taiwanese, Vietnamese), three Black students, and one Hispanic student. One faculty member (an author, not the FYRE administrator) interviewed 18 FYRE mentors from more than 10 disciplines in STEM (one chose to be interviewed but did not want to be recorded so was not included in the analysis). When asking for consent, all participants (both students and mentors) were asked for permission to directly quote them in any future publications or presentations and, immediately after, were asked to provide a pseudonym of their choice. Participants provided one, asked for their whole name or first name to be used, or asked the researchers to choose a name for them (e.g., Mentor A).

Both interviews used semi-structured interview protocols that included questions about COVID, with shifts in emphasis based upon the identity of the interviewee. For example, the student protocol started with the following question: "How has your participation in the FYRE program been impacted after COVID-19?" For mentors, the protocol was changed from "participation" to "role as a mentor." However, since the interview was semi-structured, the question prompted follow-up questions based upon the answers given by the participants.

Interviews were transcribed and initially coded into broad categories (one being COVID-19 impact) for a larger investigation. In vivo coding and theming analysis (Saldaña 2016) coupled with nVivo™ software were used to learn how COVID-19 affected FYRE participation, mentorship, and research for mentors and students. Five themes for mentors and seven themes for students emerged from the analysis, which is discussed below.

TABLE 1. Broad Areas of Research and Sample Poster Titles as Presented by FYRE Students in Spring 2020

Area of research	Sample poster title
Anthropology	Exploration of Sub-Saharan Trade Connections through Analysis of Ancient Glass from the Archaeological Site of Walalde
Biochemistry	Modification of M13 Phage with PIII Protein for Therapeutic Nanoparticle Development
Biology	The Secret of the Wings Morphology and Species Identity
Biomedical engineering	Jaw Movement Artifacts in fNIRS Signals Measured from the Auditory Cortex
Chemical engineering	Expanding ATRP for Acidic Phosphonate Monomer Synthesis
Chemistry	Carbene-Initiated Cascade Reactions for the Synthesis of Diverse Scaffolds
Computer science	Modeling the Evolution of Communication Using Artificial Neural Networks in Foraging Environments
Electrical engineering	Creating a Bird Phantom
Health and exercise sciences	Oral Contraceptives and Exercise-Induced Fatigability
Mathematics	An Exploration of Non-Euclidean Geometries
Mechanical engineering	Micro-Encapsulated Phase Change Material Within a Multi-Phase Flow Loop
Meteorology	Analysis of the Diurnal CO_2 Cycle and Its Daily Variations
Physics and astronomy	The Methods of Modeling White Dwarfs and the Importance of Their Continued Study
Plant biology	Drought Resistance of Switchgrass Genetically Engineered for Biofuels
Psychology	Evaluation of the Cognitive Effects of Iron Deficiency
STEM education	Schema-Based Instruction for Improving the Mathematical Problem-Solving Skills of a Rural Student with EBD

TABLE 2. Effects on FYRE Student Research Projects after COVID-19 Shutdown in Spring 2020

Effects on student projects	No. of students (n = 72)	Percentage of students
Switched to data analysis (self-collected)	8	11%
Switched to data analysis (previously collected)	17	23%
Conducted literature review	28	39%
Did not receive guidance	5	7%
Did not experience change in research activity	12	17%
Did not present	2	3%

Results

Impact on Mentors

Interview evidence indicates that, during this difficult time, mentors adapted their mentoring style and research expectations to prioritize students' personal well-being over research progress (see Table 3). This often meant regularly checking in with their FYRE students, as Mentor D stated: "Mostly making sure that they've got what they need just as people… that they're healthy, that they know that somebody cares about them, that they know that there is a faculty member who just wants to make sure everything's okay." This also involved lessening students' workload, especially if mentors discovered that the students faced difficulties in their personal lives. Mentor responses also showed that they attempted to create stability by holding regular research meetings and found that these meetings were a positive distraction for some of their students. In interviews, mentors most frequently mentioned adjustments to research projects, with 76 percent of mentors indicating that they adapted to COVID-19-related interruptions by switching from lab research to computational projects or research-related reading groups. Some mentors indicated that they did not need to adapt their research goals, because they had already conducted their lab work and were focusing on out-of-lab analysis or because they did not need lab access. Finally, mentors lamented the lack of a physical presence on campus, noting it was a detriment to both the

TABLE 3. Frequent Themes Repeated during Mentor Interviews, with Frequency, Definition, and Sample Quotes

Mentor themes	No. of mentors (n = 17)	Definition	Sample quote
Adjustments in projects	13 (76%)	Shifting to a different aspect of the project, finishing writing, continuing reading, or starting a new project	"What we did was we shifted everyone to a computational project. And I've always had some computational pieces to my research." – Mentor A
Care about students	12 (71%)	Addressing the safety and well-being of the students	"Just a lot of challenges for my students, and I just don't know how we can actually help them besides just encourage them to think positively, and just be more patient and more generous to the students." – CHL
Physical presence on campus	8 (47%)	Speaking on the lack of physical presence and its difficulties	"I want them to be able to see what other people are working on and participate in that atmosphere. So, I miss that. That's tough on the students—I know the FYRE student in particular." – John
Time issues	3 (18%)	Lack of time for mentors or students to adequately finish projects	"I've had to prioritize who gets most of my time because there's just not much to be had, including, you know, for me to do anything. So, my undergraduate students have gotten a lot less of my time because of that." – Mentor D
Weekly interaction	10 (59%)	Met with students consistently, often weekly, and students benefited	"I think they've mentioned several times about how much they appreciate still keeping our meeting times, even if they're briefer, [but] still keeping communication going to stay in touch." – Mentor B

students and mentors because of the loss of spontaneous interactions and discussion opportunities.

Impact on Students

Students most frequently mentioned specific research hardships and disappointments relating to the campus shutdown (see Table 4). For example, Andy set up his experiment in the first few months of the semester but was unable to continue it: "And so we're just ready to start taking data and then the whole COVID happened and nope, not happening. So that's kind of really just unfortunate." Students also reported difficulties outside of their research, including upheaval relating to sudden moves, working environments, and classes. For some, these difficulties turned into lost opportunities, including lost internships, lost interactions in physical space, and wishes for research that could provide balance with schoolwork. For example, Dakota stated, "So I miss it. Miss it so much. But yeah, that's about it. I feel like it made me appreciate it more now because before, towards the middle of the semester, [I was] also stressed. I really wanted a little [inside of the] lab." Students also showed resilience, with four students discussing how COVID-19 caused a shift in research to writing, reading, or other topics. Finally, for some, it was business as usual. This was either through a continuation of weekly meetings or an indication that no COVID-19-related shift occurred in their research activities or interactions.

Mentor-Mentee Pairs Analysis

There were four mentor-mentee pairs out of the 45 participants. The lack of pairs may be due to the recruitment call that was sent to all previous participants of the FYRE program and not specifically spring 2020 participants. Three students of the four pairs mentioned that there was no change or impact on their research, and the fourth (RockPaperGun) stated that the chemistry lab shut down. SS, the mentor, stated that she wanted to "give them some space," because the situation of going online was "unusual," especially "cop[ing] with online classes." RockPaperGun said he had "positive, longer interactions" with SS and planned on continuing research when the lab reopened.

Julian, a student who worked with Michael in meteorology, spoke about how it was "harder to get things accomplished online," but his mentor and others "dealt with the shutdown situation very well." Michael, on the other hand, spoke about how it would be easier to interact in person and that all but one student had been "ultra-enthusiastic." He said that the other student suffered from the transition to an online environment, conjecturing that the student was struggling with other classes that had transitioned to an online space. Malik, a student with Mentor A, did not have any changes with the shift online and said that he appreciated researchers, especially ones in the front lines of COVID-19 since he had begun researching. Mentor A

TABLE 4. Frequent Themes Repeated during Student Interviews, with Frequency, Definition, and Sample Quotes

Student themes	No. of students (n = 28)	Definition	Sample quote
Appreciate researchers when in pandemic	7 (25%)	Understanding of what researchers are going through, especially COVID-19 research	"If you didn't have that FYRE experience, you're just like, '. . .research is boring' . . . especially with COVID-19 going around, and people trying to find a cure. It helps me understand more of what's going on and how important it is for these health professions to actually find a cure for it." – Malik
Difficulties of researching	18 (64%)	Stating the hardships that were specific to research that occurred due to shutting down the campus	"It stopped everything. Because all our research is based in the lab, they can't really do much outside. Yeah, we can read literature and help with that. But … we need to troubleshoot some reactions that we can't really do right now anymore." – Christine
Lost opportunities	15 (54%)	Speaking of the opportunities lost or modified due to COVID	"I was going to present our paper at a conference in April, but [it] did not happen. So that was going to be cool as a culmination point of my research." – Emma DeAngeli
No change or impact	9 (32%)	Mentioning that there was no change or impact on the student from shutting down campus	"I can do most of my work through remote meetings and remote communications with people and connecting remotely to the computers in the department. So, I would say [research was affected] very hardly at all." – Ryan Hazlett
Outside of research difficulties	8 (29%)	Hardships that were outside of research that influenced participation	"Because of [moving], I didn't do any coursework for a week and was behind on the catch-up and all that. And, I also just don't have a good working environment like this. Where I'm at right now is not a proper desk. It's basically a dresser." – James
Shifts in research	4 (14%)	Writing or reading instead of doing research	"I was able to summarize what they had done in the past semesters. I didn't have anything of my own to present." – Katie
Weekly meetings	11 (39%)	Met with mentors or graduate students weekly and consistently	"We still have the same meeting schedule that we would normally. So, we have one group meeting every week and then we each have scheduled individual meetings that still occur." – Cora

had mentored many other FYRE students and kept emphasizing care of students (five times coded in the transcript), weekly meetings, and an adjustment to computational projects. Finally, prior to the shutdown, John had set up his student SF with the equipment necessary to conduct research on electrical engineering at home, so other than holding weekly meetings online, there was no change to or impact on their research.

Discussion

Consistent with previous literature that examined the changing environment brought about by disasters (Wright and Wordsworth 2013), these results suggest that COVID-19 inspired constructive and empathetic action by both mentors and undergraduate FYRE participants to ensure successful and continued collaboration over the remaining spring semester. Most mentors and students noted adjustments to projects, with a greater reliance on reading, computation, literature-based researching, and writing offsetting the halt in campus-based activities. However, compared to their mentors, students more often discussed these transitions as lost opportunities instead of as shifts in research. This may be in part due to time frame; many students were relatively new (having less than one semester of research experience) and were looking forward to the laboratory work or presenting, including the physical presence of researchers. This underscores the importance of professional development and networking as elements of the undergraduate research experience (Shanahan et al. 2015). Although both students and mentors also discussed weekly meetings and the stability those provided, students noted that it still lacked the physical environment conducive to spontaneous conversation, connections, and manipulation of research items that occurred especially in wet labs.

Differences between mentors' and students' perceptions regarding the effects of COVID-19 were also evident in, for example, the frequent citations of the pandemic by student interviewees as evidence of the importance of scientific research. One student, Robert Cascella, stated:

> I've just been hoping that the general public will see how important that science researchers are because they are our best chance of getting clinical studies done on drugs that could potentially be used or working on the vaccines that are in production. I just appreciate researchers more in times like this and I hope that everybody else does, too. Because without them . . . we wouldn't have anything.

Students also reported difficulties with the shutdown of campus, including both research challenges (e.g., not being allowed in the labs) and external complications (e.g., needing to do classwork amid a move home). Although mentors often used different language to discuss student challenges, meaning there was not a common theme in the coding, mentors commonly discussed their responses to the difficulties faced by the students. Twelve of seventeen mentors talked about their care for students such as adjusting their research expectations so that students can handle those difficulties. Mentoring literature suggests this care can make a huge difference in students' lives both in the short term (with psychological relief) and in the long term (with reconceptualizations of beliefs about the actions and mentoring of professors/researchers; Shanahan et al. 2015). Specifically, educators' emotional support for students can enhance student learning even at a distance (Cleveland-Innes and Campbell 2012), increase STEM student retention (Christe 2013), support ethnically diverse students in bridging perceived barriers (Amaro, Abriam-Yago, and Yoder 2006), help address students' psychological needs in the face of disaster (Wright and Wordsworth 2013), and improve student resiliency in response to disaster (Joshi et al. 2018; Warbington et al. 2019).

Although the FYRE program at OU provides substantial opportunities for students to professionally develop, neither FYRE nor the university provide formal training to faculty on the effective mentoring of students. This type of training in mentoring is uncommon at most institutions (Hund et al. 2018), yet responses from both faculty and students underscore the importance of mentoring relationships in weathering the COVID-19 shutdown. Mentor responses largely reflected an approach based around flexibility, communication, and empathy in their support of undergraduate researchers through the start of the pandemic. These are characteristics of successful mentoring often emphasized by mentor training initiatives (Hund et al. 2018; Keyser et al. 2008) such as focusing on emotional support (Opengart and Bierema 2015) and the importance of articulating and aligning expectations to the student's circumstances and goals (Limeri et al. 2019). When considered in the context of evidence-based practices of undergraduate research mentorship (Shanahan et al. 2015), the participants showed a strong commitment to four common practices:

1. Conducting strategic pre-planning of research (by creating a scope of research that had adjustments in projects)
2. Balancing rigorous expectations for research with emotional support and appropriate personal interest in students (by addressing the safety and well-being of the students)
3. Building community among members of the research team (through weekly meetings)
4. Dedicating time to one-on-one, hands-on mentoring (through both meetings and care for the students).

Broadly, mentor responses demonstrated the importance of being flexible in uncontrolled situations. This may help the students develop resources, communication, and trust—properties associated with becoming better scientist leaders (Hund et al. 2018). As all participants in this research were STEM students and faculty, these results suggest generalizable differences across a range of STEM fields. Whereas some students had no change due to the pandemic, others had to shut down all research labs and pivot their work. Physically-located labs were impacted in at least two ways due to COVID: the data could not be collected, and difficulties existed in attempting to replicate "spontaneous interactions" with others in the lab when online (as Ashley stated in her interview).

Interestingly, the results are consistent with findings of other research programs similarly impacted by the COVID-19 pandemic, emphasizing the importance of providing continuity in the research program despite the challenges posed by COVID-19 (Speer, Lyon, and Johnson 2021), increasing flexibility and support considering the virtual environment (Hall et al. 2021), and developing innovative ways to complete research goals (Bintliff et al. 2020). The analysis here also provides future insights into mentoring mentors: providing faculty with additional resources in the form of training programs or workshops on approaches to build in flexibility and demonstrate empathy may broaden their skill set and increase positive outcomes for students, even during (or especially after) a pandemic. Specifically, future consideration could also be given to delivery of effective mentoring, ways to think about different projects for difficult situations, comprehension of students' personal difficulties that can affect decisions about research time, and reconceptualization of opportunities to introduce undergraduate students to individual fields in STEM.

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Miloš Savić, Naga Rama Kothapalli
University of Oklahoma, savic@ou.edu, ramakn@ou.edu

Miloš Savić has been an associate professor in OU's Department of Mathematics since 2013. He earned his PhD from New Mexico State University and conducted his postdoctoral work at Michigan State University. He is currently researching in the areas of mathematical creativity and undergraduate research opportunities.

Naga Rama Kothapalli is an assistant professor in OU's Department of Chemistry and Biochemistry since 2017. She earned her PhD from University of Nebraska–Lincoln and conducted her postdoctoral work at the National Institute on Aging, National Institutes of Health. She is interested in developing course-based undergraduate research experiences in biochemistry and undergraduate STEM education. Her current work involves understanding the critical factors that influence a student's decision to pursue a career in STEM research. She is the principal investigator on the NSF grant that funded this work.

Hayley C. Lanier is an assistant professor in OU's Biology Department and an assistant curator of mammals at the Sam Noble Museum. She earned her PhD in biology from the University of Alaska Fairbanks. Her research is focused on using evolutionary ecology to inform conservation, with an emphasis on small mammals. She enjoys incorporating research into her courses and is part of the Squirrel-Net CURE leadership team.

Erin K. Freeman is an associate professor and master teacher of applied statistics in OU's Psychology Department. Her primary research interests focus on statistical pedagogy, undergraduate student success, and personality and individual differences in the experience of emotion. She earned her PhD in psychology from OU.

Lisa Ratliff is an undergraduate from Tulsa, OK who joined the Lanier Lab in fall 2018, with interests in museum collections and biodiversity outreach. Her projects have focused on using museum specimens to assess trends as well as testing for invasive DNA. She is pursuing her master's in science education with a focus on science communication.

St. Louis native Emma Hillermann graduated from OU with a bachelor of science in mathematics with minors in computer science and French. She is researching the impact of undergraduate research opportunities on students' academic growth.

Courtney Martin recently graduated from OU with a bachelor of arts in psychology. She is a research assistant on the impact of undergraduate research opportunities on students' academic growth.