Nebraska Remote Researchers: The Crop Root Microbiomes in Your Backyard summer

In the summer of 2020, CRRI introduced a new summer program for high school students. The program was developed by two CRRI researchers and carried out by their graduate students and a PhD candidate. Student participants in this program were provided with kits including tools and protocols for growing maize and sorghum cultivars in 10'x10' plots. Student participants gained hands-on experience conducting experiments that served both the CRRI project and a related NSF-funded collaborative project. The program included ten high schoolers from across Nebraska and six high school students from Alabama affiliated with the Hudson-Alpha Institute. Students participated in weekly Zoom calls and a final data workshop to analyze microorganisms from root samples collected from their plots.

Response Rate

The Nebraska Remote Researchers Survey was provided by the project Outreach Coordinator to participants. An anonymous online survey link was provided to a total of 16 participants, 14 of whom responded, yielding a response rate of 87.5%.

Reasons for Attending

Participants who completed the survey provided reasons for attending camp. In addition to being presented with eight multiple choice options, respondents could provide their own reasons under "Other" or "None of the above". The most frequently selected choice was *enhance my resume, explore my interest in STEM,* and *gain a hands-on experience in STEM* (all 71.4%). Table 1 provides additional details.

Table 1. Reasons for Attending the Remote Research Experience (*N* = 14)

Response	Frequency	Percent
Enhance my resume	10	71.4%
Explore my interest in STEM	10	71.4%
Gain hands-on experience in STEM	10	71.4%
Have a good intellectual challenge	8	57.1%
Participate in a program with a strong reputation	8	57.1%
Clarify whether I want to pursue a STEM career	7	50.0%
Clarify which field I want to study	5	35.7%
Clarify whether college would be a good choice for me	1	7.1%
Other	—	—
None of the above	—	—
Note. May sum to greater than *N* as participants could select multiple responses		

Experience with Staff and Overall Satisfaction

Fourteen respondents provided feedback about their satisfaction with the remote research experience. Table 2 shows that 100% of students reported that staff *treated them with respect*. Roughly three-fourths reported that staff *believed in their potential to succeed in STEM* (*M* = 3.71) and *encouraged them to get involved with STEM activities and organizations* (M = 3.57). More than half believed they were *encouraged to meet with teachers about their STEM interests* (*M* = 3.50), however, a few students were less sure, reporting "sometimes" and "never".

Table 2. Please select the answer that fits best: The faculty researchers who guided me... (*N* = 14)

Response	Never	Sometimes	Usually	Always	Mean (SD)
Treated me with respect.	—	—	—	14 (100%)	4.00 (0.00)
Encouraged me to get involved with STEM activities and organizations.	1 (7.1%)	1 (7.1%)	1 (7.1%)	11 (78.6%)	3.57 (0.94)
Encouraged me to meet with teachers about my STEM interest.	1 (7.1%)	4 (28.6%)	—	9 (64.3%)	3.50 (0.86)
Believed in my potential to succeed in STEM.	—	1 (7.1%)	2 (14.3%)	11 (78.6%)	3.71 (0.61)

Table 3 indicates that all respondents agreed or strongly agreed the research experience *enabled them to get hands-on experience in STEM* (*M* = 4.57) and was *worth their time* (*M* = 4.50). Just over three-quarters agreed or strongly agreed the experience was *organized and well run* (*M* = 4.14).

Table 3. Please select the answer that fits best: The remote research experience... (*N* = 14)

Response	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Mean (SD)
Was organized and well-run.	—	1 (7.1%)	2 (14.3%)	5 (35.7%)	6 (42.9%)	4.14 (0.95)
Enabled me to get hands-on experience in STEM.	—	—	—	6 (42.9%)	8 (57.1%)	4.57 (0.51)
Was worth my time.	—	—	—	7 (50.0%)	7 (50.0%)	4.50 (0.52)

When asked whether they would recommend the remote research experience to a friend, all students (100%) responded “yes”.

Table 4. Would you recommend this remote research experience to a friend? (*N* = 14)

Response	Frequency	Percent
Yes	14	100%
No	—	—
Unsure	—	—

<u>Suggestions for Improving the Remote Research Experience</u>

An open-ended survey item was used to gather suggestions for improving the remote research experience (*n* = 11). The verbatim responses below were coded for themes, the most frequent of which was to improve communication during the experience and improve the frequency and structure of weekly meetings (*ns* = 3). Students also mentioned providing additional information or educational recommendations at the end of the experience (*n* = 2). Verbatim comments are listed below by theme.

Improve Communication (*n* = 3)

- *I think communication could have been better. In the beginning, we were told the project would [last] only 6 weeks and be done by the end of July it then went on for 2 more weeks. I also wasn't sure what I was supposed to look for or do with the plates. I also thought the Zooms weren't necessary every week when we were only watching the plants grow and take measurements.*
- *I would choose to improve the wording of the instructions because some things were hard to understand especially after the root harvesting.*
- *Perhaps streamlining communication between Nebraska and the students in Alabama.*

Improve the Frequency and Structure of Weekly Meetings (Zoom) (*n* = 3)

- *Have more of a solid lesson plan for the Zoom.*
- *Having the weekly Zoom meetings earlier in the day.*
- *Perhaps we could have meetings more often (for instance, twice a week) to better monitor the overall progress of the research.*

Positive Comment about the Experience (*n* = 2)

- *I thought they did a really good job with everything.*
- *It was ran well even under COVID conditions.*

Offer Information and Recommendations when the Experience Ends (*n* = 2)

- *I would like to receive an update on the research and what information was found. I want to write a speech or paper about this remote research experience, so I really want to receive more information about the research.*
- *I would recommend that at the end of the experience that the instructors could give suggestions towards what the kids could possibly do next. That's how I stumbled upon this experience and I would like to continue my chain of learning about other experiences through the previous one and I hope other kids can start or continue their own chains.*

None (*n* = 1)

- *None.*

STEM Interest Before and After the Remote Research Experience

Respondents indicated the degree to which their interests in STEM changed or remained the same as a result of participating in the remote research experience. On a five-point scale (1 = Decreased significantly to 5 = Increased significantly). Nearly all respondents reported an increase in *the way STEM helps people* (*M* = 4.31). Respondents also reported increased interest in *reading websites, articles or books about STEM issues* (*M* = 4.20) and *organizations or groups related to STEM* (*M* = 4.15). The mean rating for increased interest in a *career that uses STEM* was the lowest rated of the four statements (*M* = 4.08); however, it was still rated above the "increased slightly" category (a 4.0).

Table 5. As a result of participating in this experience my interest in…

Response	Decreased Significantly	Decreased Slightly	Did Not Change	Increased Slightly	Increased Significantly	*N*	Mean* (SD)
Organizations or groups related to STEM…	—	—	1 (7.7%)	9 (69.2%)	3 (23.1%)	13	4.15 (0.53)
Reading websites, articles or books about STEM issues…	—	—	1 (10.0%)	6 (60.0%)	3 (30.0%)	10	4.20 (0.60)
The way STEM helps people…	—	1 (7.7%)	—	6 (46.2%)	6 (46.2%)	13	4.31 (0.82)
A career that uses STEM…	—	1 (8.3%)	1 (8.3%)	6 (50.0%)	4 (33.3%)	12	4.08 (0.86)
*Mean based on 1 = Decreased significantly to 5 = Increased significantly.							

STEM Attitude Before and After the Remote Research Experience

Respondents indicated the degree to which their attitude regarding various STEM activities described themselves as a result of participating in the remote research experience on a five-point scale scale (1 = Decreased significantly to 5 = Increased significantly). All items scored above a 4.0 (the "increased slightly" level). Respondents reported the greatest increases in their *pride in their accomplishments in STEM* (*M* = 4.50); their *comfort talking to people who work in STEM careers* (*M* = 4.46); and their *confidence conducting STEM activities* (*M* = 4.43). Table 6 presents a more detailed description of responses to these items.

Table 6. As a result of participating in this experience...

Response	Decreased Significantly	Decreased Slightly	Did Not Change	Increased Slightly	Increased Significantly	*N*	Mean* (SD)
My comfort talking to people who work in STEM careers…	—	—	—	7 (53.8%)	6 (46.2%)	13	4.46 (0.50)
My enjoyment participating in STEM activities...	—	1 (8.3%)	—	6 (50.0%)	5 (41.7%)	12	4.25 (0.83)

Response	Decreased Significantly	Decreased Slightly	Did Not Change	Increased Slightly	Increased Significantly	*N*	Mean* (SD)
My ability to see myself as a STEM person…	—	2 (15.4%)	—	6 (46.2%)	5 (38.5%)	13	4.08 (1.00)
My confidence conducting STEM activities...	—	—	—	8 (57.1%)	6 (42.9%)	14	4.43 (0.49)
My pride in my accomplishments in STEM...	—	—	—	6 (50.0%)	6 (50.0%)	12	4.50 (0.50)
*Mean based on 1 = Decreased significantly to 5 = Increased significantly.							

College and Career Plans Before and After the Remote Research Experience

Respondents reported their college plans retrospectively for both before and after their research experience participation on a three-point scale (1 = I did/do not intend to complete a Bachelor's degree in a STEM field to 3 = I definitely intend(ed) to complete a Bachelor's degree in a STEM field). The mean rating before was 2.36 while the mean rating after was 2.64, indicating that although most participants' ratings were already in the "considering" range before the experience there was an increase towards a "definite" intention to *complete a Bachelor's degree in a STEM field* after participation in the program. For a more detailed description of responses to these items, see Table 7.

Table 7. College Plans Before and After the remote research experience (*N* = 14)

Response	Before Frequency (%)	After Frequency (%)
I did not intend to complete a Bachelor's degree in a STEM field.	2 (14.3%)	1 (7.1%)
I was considering completing a Bachelor's degree in a STEM field.	5 (35.7%)	4 (28.6%)
I definitely intended to complete a Bachelor's degree in a STEM field.	7 (50.0%)	8 (57.1%)
Other	—	1 (7.1%)
"Other" AFTER response (n = 1): I don't know for sure what my college plans are. Mean "Before" = 2.36; Mean "After" = 2.64		

Respondents also reported their career plans retrospectively for both before and after participation. Following the remote research experience, the means for two of the three career plans increased from before-to-after. Means from before-to-after increased by 0.29 for both *pursuing a career conducting research* and *pursuing a career in a STEM field*. The mean was remained the same for *pursuing an advanced degree* (*M* = 2.29). Table 8 presents a more detailed description of responses to these items.

Table 8. Which best describes your career plans? (*N* = 14)

Response	Before After	Not Likely	Likely	Very Likely	Mean (SD)
Pursue a career conducting research	*Before*	4 (28.6%)	10 (71.4%)	—	1.71 (0.47)
	After	2 (14.3%)	10 (71.4%)	2 (14.3%)	2.00 (0.56)
Pursue a career in a STEM field	*Before*	4 (28.6%)	4 (28.6%)	6 (42.9%)	2.14 (0.86)
	After	1 (7.1%)	6 (42.9%)	7 (50.0%)	2.43 (0.65)
Pursue an advanced degree (Master's, PhD)	*Before*	2 (14.3%)	6 (42.9%)	6 (42.9%)	2.29 (0.73)
	After	2 (14.3%)	6 (42.9%)	6 (42.9%)	2.29 (0.73)

In the survey, respondents were also asked directly whether their educational and/or career intentions changed as a result of their remote research experience. Half of the respondents (50.0%) reported their intentions *did* change as a result of their experience. A little over a third of students (35.7%) reported that their intentions *did not* change, and a couple of students (14.3%) reported that they were *unsure*. For a more detailed description of responses to these items, see Table 9.

Table 9. Career Intentions Before and After the remote research experience (*N* = 14)

Response	Frequency	Percent
My intentions did not change.	5	35.7%
My intentions did change AND changed as direct result of this summer experience.	7	50.0%
My intentions changed BUT NOT as a result of this summer experience.	—	—
I am uncertain.	2	14.3%

Respondents were given an opportunity to offer any additional comments, if desired, and to describe anything particularly surprising or meaningful. Seven respondents provided examples of ways the camps offered them learning experiences and opportunities to participate in STEM. Verbatim quotes are:

- *I loved being able to work with such an amazing and supportive group of people! The teachers and instructors were so incredible! I had so much fun learning more about the STEM field and some of the research I would be conducting if I went into Agriculture. It was incredibly helpful in discovering my passions for different areas of biology!*
- *I realized that research might be what I am interested [in], especially with plants.*
- *I was surprised by how invested I got into the remote research experience. I did not think that I would enjoy it as much as I did, but it became quite the interesting summer project.*
- *It was a lot more factual and informative than most other science experiences where you mix two files together and see a colorful chemical reaction. It was educational, informative, and I wish more like it would exist.*
- *It was surprising growing the bacteria on the petri dishes.*
- *The program helped me to think about plant genomics, which I had not much before.*
- *This whole thing was meaningful because I know what is going on in biology and plant science before it is taught so it makes everything much easier.*