Eve Perara, Ph.D.; Director of Diversity, Education, and Outreach
Nadine Gruhn, Ph.D.; Managing Director
Center for Enabling New Technologies Through Catalysis

April 23, 2018

Running a summer research program for undergraduates in a distributed research center

Background

Value of undergraduate research

Participation in undergraduate research has been shown to be a transformational experience for STEM students. Relative to students who have not had a research experience, those who do participate in research as undergraduates are more likely to persist in STEM fields as well as to continue on to post-graduate programs.[1] This is true for all undergraduates, but the gains of students from traditionally underrepresented groups have been reported by some to be even greater than those experienced by those from majority groups.[2] The demonstrated effectiveness of undergraduate research experiences in student retention in STEM has resulted in the development of many research programs specifically targeting minority students.

Characteristics of effective undergraduate research programs

Research in the field has identified characteristics of undergraduate research that most correlate with positive outcomes that enhance student achievement. Effective mentorship, participating in authentic research, learning research skills and participation in professional development activities serve to integrate students into the research community. In turn, the degree to which a student identifies as a member of the scientific community correlates positively with persistence in STEM to achieve a degree and to go on to post-graduate study. [3-4]

Many undergraduate research programs include group instructional and social activities to develop a strong student cohort among their participants. Such a cohort experience has been shown to increase the effectiveness of the programs, particularly for non-white students.[5]

Introduction

Given the demonstrated benefits of research experiences to undergraduates from minority backgrounds, CENTC developed a summer undergraduate research program as a part of our diversity efforts. Developing and running a summer program with participants placed in research groups across the country presented both challenges and opportunities. Here we present how CENTC was able to leverage its strengths to provide an innovative and effective undergraduate summer research program to include students from populations underrepresented in chemistry including women, minority groups and those with disabilities.

CENTC

Phase I

During Phase I of the Center (then called the Center for the Activation of Strong Bonds or "CATSB") a summer undergraduate research program was a central focus of diversity and education programs. Students were selected by principal investigators with the intent to include students from populations that are underrepresented in chemistry. Undergraduates were integrated into the Center's collaborative culture by working on collaborative CATSB research projects and attending bi-monthly center-wide videoconferences. They also met via videoconference to discuss research results, learn about career pathways and present their research. Through use of videoconferencing students were able to experience how collaborative research is done and how to communicate across distances, becoming familiar with cutting edge videoconferencing technologies. The program was successful in its aim to broaden participation in chemistry; well over half the participants were women or underrepresented minorities.

Phase II

In Phase II, the Center, renamed "Center for Enabling New Technologies Through Catalysis" (CENTC), grew to include more principal investigators, students and postdocs at additional sites as well as 3.5 FTE staff: Managing Director; Director of Diversity, Education and Outreach; Assistant to the Director and a half-time IT Director. With dedicated staff in place, CENTC was able to grow their broader impact initiatives, including the undergraduate summer research program.

Undergraduate research program development

CENTC planned an expanded and enriched summer program initiated in the summer of 2009. Changes included nationwide recruitment targeting women and minorities, a centralized application and selection process, a stipend plus funds for travel and housing, and formalized professional development activities through weekly videoconference meetings that included all students and the Director of Diversity, Education and Outreach. The program, referred to as the CENTC Undergraduate Summer Research Program (USRP), strongly encouraged applications from women and students from underrepresented groups.

Prior to the first summer research program in 2009 we consulted with an independent evaluator, Instruction Development and Evaluation Services, who guided us in articulating specific goals for the program, how we would achieve those goals, and how we would know that each goal had been achieved.

Goals for CENTC summer undergraduates:

Many of our goals were those shown to correlate most with student success in STEM. Others were specific to CENTC, aligning with our strengths, such as learning about collaboration, familiarization with videoconferencing and valuing the experience of working as part of a large collaborative organization:

- Experience the life of a graduate student at a research-intensive university
- Learn how research is done
- Increased confidence in conducting and presenting research
- Integration into scientific community
- Clarification of educational and career goals
- Learning the ins and outs of videoconferencing
- Understanding the value of collaboration in research
- Understanding how individual research projects fit into the larger research goals of their lab and of CENTC
- Recognize the difference between conducting research as part of a research center relative to working in an independent research lab

Evaluation of year 1

Having established specific goals for our program, we continued working with our independent evaluator to create an appropriate survey instrument (See Appendix) to determine the effectiveness of the USRP experience in achieving those goals. Using a 5-point Likert scale students were asked to rate the degree to which they had developed specific skills as a consequence of their participation in the program. These included laboratory skills as well as learning about graduate school, careers in chemistry, etc. We asked the frequency with which they participated in research related activities such as group meetings, presentations or reading primary literature and the quality of the mentoring they received. These are activities that serve to integrate students into the scientific culture. These activities and student reports strongly correlate with retaining students in STEM. The survey also measured whether students had achieved CENTC-specific goals such as competence with videoconferencing, understanding how individual research projects fit within the goals of the individual laboratory and the Center, and appreciation of the difference between conducting research in a traditional single-investigator lab and working in a collaborative research center.

Following the first summer program in 2009, an extensive evaluation was carried out by our consultant. The survey was followed up with phone interviews between individual students and our consultant and a summary of those conversations was provided. Results from this extensive evaluation informed us moving forward with our program.

Results of the survey and interview showed that, on average, participants reported that skills, learning and experiential outcomes were improved as a consequence of participation in the

program and that they felt more a part of the chemistry research enterprise than they had previously. However, understanding and appreciating specifics of conducting research in a collaborative research center had not improved, particularly, how the center research experience differed from that in a traditional single investigator lab and the advantages of collaborative research.

Integrating the summer undergraduates into the collaborative culture of the center was what set CENTC's program apart from other programs so we explored changes to our program to strengthen our students' experience with CENTC's collaborative approach to research. Realizing that participating for 10 weeks in a single investigator's lab with only a handful of communications with remote collaborators didn't give students a flavor of collaboration, we decided to include summer undergraduates in an in-person experience with all members of CENTC to provide a vivid example of collaboration in action. CENTC held two-day annual meetings each fall on the University of Washington campus in Seattle, that included all PIs, graduate students, postdocs, industrial affiliates and a representative from NSF. These provided the opportunity for important in-person interactions, updates on all of the Center's projects and time to plan for the coming year.

In 2010 undergraduates were invited to participate in the 2010 annual meeting in September, all expenses paid. Over ¾ of the students attended. CENTC staff arranged for travel, lodging and a welcome event for the students. Students presented their summer research in the poster session alongside CENTC postdocs and graduate students. In surveys administered following participation in the annual meeting, students reported improved understanding of what a research center was and how CENTC operates as well as appreciation for the power of collaboration. Subsequently, participation in the CENTC Annual Meeting was incorporated into the program as an optional capstone experience.

Logistics

Recruitment process

Our recruitment was nationwide and targeted students from underrepresented groups and those without access to an R-1 research experience. We began annually in October by sending electronic flyers to undergraduate advisors and faculty at Historically Black Colleges and Universities and minority serving institutions and to regional and national offices of National Organization for Black Chemists and Chemical Engineers (NOBCChE), Society for the Advancement of Chicano and Native American Sciences (SACNAS) and Hispanic engineering student organizations. The USRP was listed with other research opportunities including ACS (http://getexperience.acs.org/jobs/), Pathways to Science (http://www.pathwaystoscience.org/) and SACNAS. The director attended national meetings of SACNAS and NOBCChE to reach out in person to undergraduate attendees. We asked CENTC faculty, students and postdocs, and previous USRP students to send information on the USRP to their colleagues. Information about the USRP and the application process was posted on the CENTC website, and was also advertised broadly

through the social media platforms Facebook and Twitter. Each year 1-2 ad campaigns would be run on Facebook to "boost" a post about the research opportunity, particularly targeting an audience of Facebook users who had self-identified themselves in their profile as undergraduate chemistry or chemical engineering majors.

Application process

After using other application processes, in 2014 we settled on a commercially available form builder and data collection service, Form Assembly. Cost for this service was minimal and we paid only for the months that it was in use (November – June). The user-friendly platform allowed us to customize our application form and system to meet our needs. We were able to design a collection method where each applicant was identified by a unique email address. When students entered the name and email of the two references, the service automatically contacted the individuals with instructions on how to submit their references. Students were then contacted automatically when each reference's email was uploaded and again when their applications were complete. Students were able to save partially completed applications and re-enter to edit or to add more info until it was submitted. They also could check in to view the status of their applications. This system linked references and transcripts to the appropriate application, greatly simplifying and streamlining the review process.

Applications became available on our website in late November, with a deadline in early February, and were reviewed as they were received. We required a statement from the student describing academic background and professional and career goals and how participating in the CENTC research program, specifically, would help to further those goals. In addition, unofficial transcripts from all post-secondary schools attended and two reference letters were required. Students were requested to list their top three choices of research labs. Demographic data using wording from the National Science Foundation was requested but was optional.

Student selection

In reviewing the applications, the student essays and the references carried the greatest weight. We were especially interested in learning if the student had some understanding of what CENTC was and what were its research aims. We also looked at whether a student was interested in our program specifically. We had no minimum GPA but did require at least one term of organic chemistry. Research experience was not required. We preferred rising juniors and seniors with an interest in chemistry careers and graduate school. For the most part we did not accept students whose educational goals were in medical fields.

The ideal applicant was a rising junior or senior from our targeted demographics with little access to a high caliber R-1 research experience. They would be interested in a career in chemical sciences and show an interest in participating in a collaborative research project using catalysis to address some of CENTC's long-term goals, such as development of biofuels and new processes for producing commodity chemicals. They would have

completed an organic chemistry series and taken or enrolled in inorganic chemistry. Their references would be able to address more than simply their grades in a class but also included information about the student's curiosity, demonstrated interest in chemistry research, hands-on skills in lab classes and a ranking of the student relative to others.

The program director reviewed all completed applications, making recommendations to accept, wait-list or deny the applicant. Notes on each application were entered into a spreadsheet to be shared with other reviewers. Another round of reviews by the managing director followed. Together the program director and managing director compiled a "short list," discussed each student on the list and tentatively matched students to faculty advisors. Every effort was made to match each student with one of the three mentors they had identified.

Once a good match was determined, the student's application was forwarded to the faculty mentor who was asked to respond in two days. In cases where a good candidate could not be matched with a requested lab, we forwarded the application to an available faculty member. If they were willing to host the student, the student was contacted to determine if they were willing to work in that lab. PIs had the final decision as to whether to host a particular student or not. If a specific student was requested by a faculty member prior to undergoing full review, that student was generally accepted to work with that faculty member and participate in the program. When an exceptional application was seen, it was sent immediately to a faculty member without going through the regular triage process in order to extend an invitation as soon as possible since outstanding students are likely to be accepted to multiple REUs.

Once the faculty member agreed to host a student, an acceptance email was sent to the applicant informing them with which PI they were matched and details about the program. A link was provided to a description of expectations and responsibilities of participants. Agreement to these terms indicated the intention to participate in the program and agreement to student responsibilities and conditions of the program:

- Abide by the policies and code of conduct of the assigned university.
- Commit a minimum of 40 hours per week in the lab for the duration of the research program, plus additional outside of lab time that may be required to complete other work – reports, presentations, etc.
- Attend weekly meetings related to the research program.
- Complete a final research paper to be approved by research supervisor.
- Satisfactorily check out of lab space at the end of the program – clean lab space, turn in any keys issued, turn in properly labeled notebooks and files, etc.
- Give oral presentations on research projects via videoconference
- Complete a program evaluation form prior to my departure.
- Provide contact information so CENTC could contact them contact in the future to track their academic and professional progress.

All but the final screening was carried out by staff without faculty input. This was the most efficient approach since staff had more time to devote to reviewing all of the applications in a timely manner than would a faculty committee or even a single faculty member. It is important to identify excellent candidates and offer them a place in the program as early as possible since there is some competition for the best candidates and students need time to make plans. Staff also kept the goals of the program in mind when selecting applicants. Faculty were relieved to not have the responsibility of reviewing scores of applications and were almost always satisfied with the selections made by the staff.

Housing/Travel

As a distributed center, with investigators at 15 different institutions, providing housing for participants proved challenging. Some institutions didn't allow summer visitors to use on-campus housing and, when housing was available, the dates often didn't coincide with students' dates of participation. Therefore, we asked our students to make their own housing arrangements. This was new for most students and was a daunting task for many. However, all students were able to secure housing for the summer, using Craigslist, host university websites or Facebook listings of summer sublets. Some responded in our end-of-program survey that, while it was a formidable task, they found it useful to make their own arrangements because this was something that they would have to do for graduate school and they appreciated the experience. A housing and travel stipend that varied according to host institution to account for different rental rates was provided to students.

When summer housing was requested by either the student on the faculty member, and it was available at the host institution, we would try to make arrangements for that. If the cost of the housing exceeded the allotted housing stipend, the difference was deducted from the $5000 stipend. Sometimes CENTC students could be included in housing for the local REU program and that provided a community and cohort during their stay.

Program Implementation

Elements of the program

- 10 weeks of full-time authentic research on CENTC collaborative research projects
- Weekly videoconferences with other USRP participants and program director –
  - Welcome and introduction to CENTC's history, research goals and sub-projects by CENTC Director, Karen Goldberg
  - Virtual icebreaker activity
  - Brief (5 min) introductions of individual research projects
  - Professional development videoconferences
    - Graduate school – preparation, applying, selecting institution and advisor
    - Careers in chemistry – variety of career paths of chemistry PhDs
    - Funding for graduate school – NSF Graduate Research Fellowship Program
  - 15 min student project updates

- Research ethics training
- Final 4-5 page research paper
- Opportunity to attend CENTC Annual Meeting

Program implementation

Our program dates corresponded to the academic calendar (quarter system) at the University of Washington where the program was administered and the videoconference schedule was planned accordingly. It wasn't uncommon for students' academic schedules to present conflicts with the official dates of our program so, with their research mentors' approval, they were allowed to conduct the 10 weeks of research on a calendar that fit with their needs. This meant missing one or two of the videoconferences at either end of the schedule, though some students were able to participate in the videoconferences even though they were not physically in the host laboratory. Those who could not, missed some of the student research reports but were still able to do both of their research updates, hear some of the others' and participate in all three of the professional development sessions.

Undergraduates were placed in laboratories that matched their interests. Graduate student or postdoc mentors worked closely with students on research projects and welcomed students into the lab group. Individual CENTC research projects were determined by the host. In addition to doing research full time, students were encouraged to read related primary literature, participate in the host lab's group meetings and in the monthly "all CENTC" videoconferences.

Students met weekly with the program director via videoconference for short project updates by students and professional development sessions. The videoconference schedule began with a welcome and introduction to CENTC from the Center's Director, Karen Goldberg. This was a comprehensive introduction explaining the Centers for Chemical Innovation program, the high-risk high-reward projects CENTC was engaged in and the importance of catalysis in solving big problems with significant societal impact. The next videoconference meeting was comprised of brief introductions (~5 min, 3-4 slides) from each student about their individual research projects. The following three weeks were devoted to interactive panel discussions on graduate school, chemistry careers and NSF graduate school funding. Panelists were located around the world and joined the videoconference from their own connections. Most provided contact information for students to follow up if they had other questions.

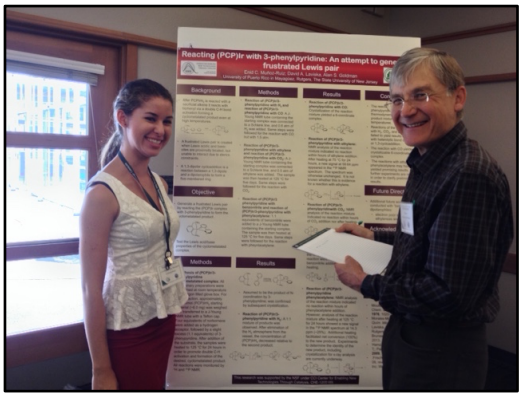
The graduate school panel was composed of 4-6 graduate students from both CENTC and non-CENTC labs as well as some who went immediately following graduation and those who took some time off between graduating and entering grad school. Panelists described the evolution of their interest in, what graduate school is like, how to prepare, and how to choose a program and a research group. The career panel included individuals with chemistry whose career paths had led to a variety of different professions– research faculty, faculty at undergraduate institutions, industry, national labs, patent researchers,

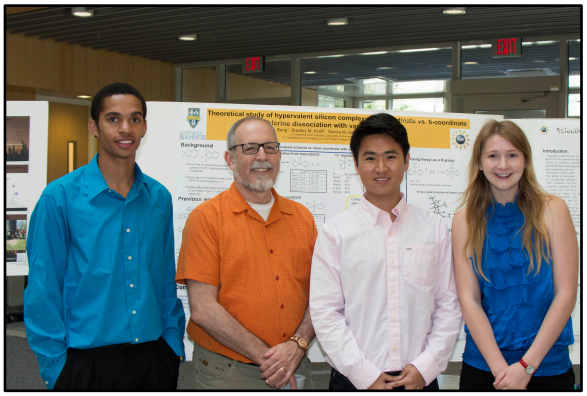
software engineers and others. Panelists described their individual paths to their current careers, what they did and the plusses and minuses of their jobs. For the NSF funding session we were joined by our program officer and the Graduate Research Fellowship Program (GRFP) program officer who presented details of the program and advice about writing a strong application. Students were strongly encouraged to apply. Final weeks consisted of 10-15 minute project updates from the summer students.

Research ethics training is required for all researchers supported by NSF. We required our undergraduates to complete online training modules developed by Center on Materials and Devices for Information Technology Research (MDITR) accessed via National Ethics Center https://nationalethicscenter.org. Students were able to complete the modules at their own pace and the director could access the progress of each student throughout the program. In addition, a brief (4-5 page) research paper summarizing their research project was required prior to completion of the program. Papers were read and edited by the research mentors, submitted to the program director and compiled into a bound volume that was distributed to all participants.

If there were other REU programs at the host institution, students were encouraged to participate in their activities. Those programs could provide them with the social and undergraduate cohort experience in their department, and other activities such as instruction on preparing a poster or GRE prep. We also encouraged them to present their work in any poster sessions or oral presentations for undergraduate researchers that were held at their host institutions.

Capstone Experience





As described previously, beginning in 2010 we included an opportunity for our summer undergraduates to attend the CENTC Annual Meeting as a culminating experience for our undergraduate summer research program. CENTC covered all travel and lodging expenses. The Annual Meeting included all faculty, postdoc and graduate student researchers, industry partners and a representative from NSF. It was an opportunity for everyone in the center to catch up on all of the research projects and provide input on future directions. as well as provide networking and recreational opportunities. Graduate students and postdocs arrived one day prior to the scheduled program for professional development. Undergraduates also arrived a day early for a welcome event planned by the director where they had the opportunity to get to know one another in a casual setting prior to the meeting.

Participation in the annual meeting gave the undergraduates the experience of attending a small scientific meeting. The morning program on Day 1 included short research talks from students and postdocs on their particular research projects. These presentations served to introduce the posters to be presented in the afternoon. Undergraduates presented their summer research alongside graduate students and postdoc at the poster session and also were able to view and discuss other Center research. It was a very valuable experience for them to engage with, and receive feedback from, prominent researchers. They had opportunities to speak with grad students and faculty about graduate programs at the universities where CENTC research was conducted. A lunch break and concluding banquet provided opportunities for continued informal interactions.

Before and after surveys showed that participation in the annual meeting gave the undergraduates a better understanding of CENTC's long-term research goals and how their

individual summer projects fit in with those goals. They also reported an increase in their appreciation for the advantages of collaborative research.

Attendance at the annual meeting required some sacrifice on the part of the students since it was held during the academic year for those on a semester system, but almost all of the students were able to attend and they found it very worthwhile and worth the inconvenience:

- (participation in the annual meeting) . . . brings the research full circle and gives you a great understanding about collaborative research and graduate school."
- ". . . .it is a great experience for explaining scientific research and a great way to help determine plans for after undergraduate studies"
- "It was very interesting to hear how a group of experts looks at/discusses their research and collaboration."
- "It was extremely interesting to talk to the graduate students whose projects were closely related to mine. It was very evident that collaborative research has led to some great advances in the field."

Ongoing evaluation and assessment

Shortly after conclusion of each summer program, students were asked to complete a survey about the quality and impacts of their experiences. Using a 5-point Likert scale, they were asked to rate their development in a variety of areas as a result of their summer experience, quantify their sense of integration into the scientific community and assess different elements of the program as to their usefulness. We used these surveys to reassess the program and to make changes accordingly.

Summative evaluation

A survey of previous participants revealed Surveying participants years after participation only two reported that the lack of student cohort was a significant drawback to the program.

Obstacles

Because we were a distributed center, our summer undergraduates necessarily were placed in CENTC labs around the country and in Canada and were often the only

undergraduates in the host lab or even in the department. We devised different ways to try to encourage our summer undergraduates to connect with one another to create a "virtual cohort." We created an online discussion board with a weekly prompt from the director hoping to get a conversation going. For several years we had one of the weekly videoconferences devoted to a "virtual icebreaker" activity so students would learn more about one another. But students consistently reported that they didn't feel that this was a good use of their time. For the last few years the director opened every videoconference with a question that required brief answers. This gave everyone a little insight into their peers without taking any extra time. Even though it was a one-time experience, it was meeting in person at our annual meetings that gave the students the sense of being part of a cohort.

Many reports indicate that involving students in research as early as possible in order to retain them in STEM and go on to graduate study. In our experience found that including rising sophomores was not successful unless the student was able to continue their research with their host lab. It worked well for faculty to identify strong freshmen in their departments and continue their summer research projects throughout their academic experience.

Lessons Learned

Be flexible. Different students have different needs and abilities and it is important to be prepared to accommodate them.

There really is no substitute for face-to-face interactions. Participation in the CENTC annual meeting allowed the undergraduates, who had conducted their summer research projects in labs across the country and in Canada, to meet one another. The introduction of the capstone experience of not only helped to convey what collaborative centers are about, but also provided the opportunity for the undergraduates to get to know one another and share their summer experiences and networking with other CENTC researchers was invaluable to them.

Move quickly on exceptional program applicants. They often receive multiple offers.

Take advantage of opportunities for undergraduate researchers at USRP host institutions. Participation in social and other activities and REUs at their host universities provided our students with a cohort experience, and opportunities for additional professional development and for presenting their research either orally or as a poster. Sometimes it was possible for CENTC students to be housed with the other REU students as well. We were able to coordinate with existing REUs at Rochester, University of North Texas, UC Berkeley, University of Wisconsin, University of Washington, and University of Michigan.

While initially daunting, the requirement for students to make their own housing arrangements was often seen as a valuable experience because it was something students would need to do if going on to graduate school.

Including rising sophomores worked well if they could continue the research in their home institutions. This allowed them to add to the skills development and sense of being part of the scientific community. Several such students included in our USRP did go on to graduate school.

Engaging all of our staff in the logistics of running the program enabled its smooth operation. The IT Director worked with Managing Director and DEO Director to find an application management platform that would meet their needs and also provided technical expertise for videoconferences. Director of Diversity, Education and Outreach recruited applicants, fielded their questions and reviewed every application. Together with the Managing Director, who had more knowledge of the chemistry field, she selected students, matched with faculty and communicated with them. DEO director ran all videoconferences, coordinated professional development panel sessions, and arranged for undergraduate program at the annual meetings. The Assistant to the Director handled all of the financial aspects of the program.

Do what you do best. We played to our strengths and didn't try to fit our program into a proscribed format of a typical REU. Since providing a strong cohort experience for our students was limited due to the distributed nature of our center, we focused on providing an experience NOT offered by most REUs: doing research as part of a collaborative team and the opportunity to network with many high-profile researchers in inorganic chemistry. Our students recognized the unique opportunity and benefited from it.

Take advantage of existing relationships with MSIs whether through center faculty or students and postdocs or through previous summer undergraduates. For example, we developed a research collaboration with a faculty member from Tuskegee University and recruited 4 Tuskegee students in 4 successive summers.

Outcomes

In all, 121 undergraduates participated in the CENTC summer research program. Of these 79 were women and 31 from other groups underrepresented in chemistry, including veterans, Hispanic, African American and Pacific Islander students and those with disabilities. At the time of this writing, of the 92 USRP alumni who graduated and for whom we have information, 56 went on to graduate school, 12 are working in chemistry, and fourteen were awarded NSF Graduate Research Program Fellowships.

References

[1] Barlow A, Villarejo, M. Making a difference for minorities: Evaluation of an educational enrichment program. Journal of Research in Science Teaching. 2004;41(9):1–21.
[2] Lopatto, CBE Life Sci Educ. 2007 Winter; 6(4):297-306.
[3] Taraban & Blanton, R.L. (Eds.), Creating effective undergraduate research programs in science. NY: Teacher's College Press (pp. 112-132).
[4] Fechheimer, M., Webber, K, and Kleiber, P. B., CBE Life Sci. Educ. 2011 Summer; 10(2): 156-163.
[5] Lopatto, D. (2004). Survey of Undergraduate Research Experiences (SURE): First Findings. Cell Biology Education, 3, 270-277.

Appendix

CENTC DEO – USRP Participant Survey: August 2009

Instructions: We appreciate your thoughtful and candid response. Your responses are confidential. CENTC staff will see only transcripts and summaries. Please mark the bubble that most closely corresponds to your opinion for each item. Pencil or ink is fine, but if you change an answer, please erase or mark correction.

Summer Research is:
- ❍ at my home institution
- ❍ at another institution

In my home program this fall, I will be a
- ❍ 2nd year student (or sophomore)
- ❍ 3rd year student (or junior)
- ❍ 4th year student (freshman

I. Rate your development in the following areas as a result of your participation in this program?	**a lot more**	**a bit more**	**no change**	**a bit less**	**a lot less**
1. Confidence in my ability to conduct research	❍	❍	❍	❍	❍
2. Comfort in discussing scientific concepts with others	❍	❍	❍	❍	❍
3. Comfort in working collaboratively with others	❍	❍	❍	❍	❍
4. Comfort in making oral presentations	❍	❍	❍	❍	❍
5. Confidence in my ability to explain my own research project	❍	❍	❍	❍	❍
6. Consistency in keeping a detailed lab notebook	❍	❍	❍	❍	❍
II. During your research experience this summer how often did you	**Almost always**	**usually**	**sometimes**	**rarely**	**Almost never**
7. Have a sense you were participating in authentic scientific research	❍	❍	❍	❍	❍
8. Think creatively about your project	❍	❍	❍	❍	❍
9. Feel a part of a scientific community	❍	❍	❍	❍	❍
III. Compared to BEFORE you began this research program, how much do you agree with the following statements?	**strongly agree**	**agree**	**uncertain, neutral**	**disagree**	**strongly disagree**
10. I have a better idea of what graduate school is like	❍	❍	❍	❍	❍
11. I know more about how laboratory research works	❍	❍	❍	❍	❍
12. I know more about the process of applying to grad school	❍	❍	❍	❍	❍
13. I understand how my research project fits into the larger research goals of the lab in which I worked	❍	❍	❍	❍	❍
14. I feel better prepared to succeed as a graduate student	❍	❍	❍	❍	❍
15. I recognize the value of collaboration in a research project	❍	❍	❍	❍	❍
16. I recognize important differences between a research center and an independent research lab	❍	❍	❍	❍	❍
17. I have a better idea of various career options in chemistry	❍	❍	❍	❍	❍

Appendix

18. I have a better understanding of strengths and weaknesses of teleconferencing	❍	❍	❍	❍	❍

IV. In your research lab	**Almost always**	**usually**	**sometimes**	**rarely**	**Almost never**
19. How often were you satisfied with the support your received from your graduate student or post-doctoral mentor?	❍	❍	❍	❍	❍
20. How often were you satisfied with the support you received from your faculty adviser?	❍	❍	❍	❍	❍
21. How often did you feel welcome by the other research personnel in the laboratory?	❍	❍	❍	❍	❍
22. How often were your non-bench lab activities (group meetings, informal interactions, teleconferences) valuable to you in learning about how research is conducted?	❍	❍	❍	❍	❍
V. Approximately how many times over the course of the program did you do the following?	**10 or more times**	**7-9 times**	**4-6 times**	**1-3 times**	**0 times (never)**
23. Give an oral presentation on your project (including AccessGrid)	❍	❍	❍	❍	❍
24. Meet with your faculty adviser	❍	❍	❍	❍	❍
25. Attend meetings of your research group	❍	❍	❍	❍	❍
26. Attend teleconferences with collaborators	❍	❍	❍	❍	❍
27. Read journal articles relating to your research	❍	❍	❍	❍	❍
VI. How satisfied were you with the following aspects of the research program?	**Very satisfied**	**Somewhat satisfied**	**Uncertain**	**Somewhat unsatisfied**	**Very unsatisfied**
28. The application process	❍	❍	❍	❍	❍
29. Comment? (optional)					
30. Availability of information to help in selecting a research laboratory	❍	❍	❍	❍	❍
31. Comment: (optional)					
32. Assignment to a research laboratory	❍	❍	❍	❍	❍
33. Support and guidance from CENTC staff	❍	❍	❍	❍	❍
34. Student stipend	❍	❍	❍	❍	❍
35. Travel/housing supplement	❍	❍	❍	❍	❍

Appendix

VII. How worthwhile was each of the following USRP Access Grid activities in contributing to your own educational and career development objectives	very worthwhile	worthwhile	somewhat worthwhile	Marginally worthwhile	worthless
36. Weekly USRP AccessGrid meetings, in general	❍	❍	❍	❍	❍
Comment?					
37. Undergraduate presentations via Access Grid	❍	❍	❍	❍	❍
Comment?					
38. Graduate student panel via Access Grid	❍	❍	❍	❍	❍
Comment?					
39. NSF graduate school funding information via Access Grid	❍	❍	❍	❍	❍
Comment?					
40. Career panel via Access Grid	❍	❍	❍	❍	❍
Comment?					

VIII. The CENTC USRP Program overall
41. What was the single most useful aspect of the CENTC USRP program?
42. What could be dispensed with?
43. What else would you change?

Please use the blank side of this sheet for any extra comments you may have.