

FINAL REPORT CHEMISTRY REU PI'S MEETING

July 8-10, 2009

San Antonio, TX

Executive Summary

The third NSF REU Chemistry PI Meeting was held from July 8 to 10, 2009, in San Antonio, TX. Supported by the NSF, the meeting was organized by members of the Leadership group and attended by a total of 62 individuals, including 53 PIs, five invited speakers, seven members of the Leadership Group and the NSF-REU Program Director. The format of the PI Meeting included brief presentations from experts followed by focused breakout sessions involving small groups of PIs, integration of ideas distilled from the breakout groups via collective reporting sessions, and identification of specific action items to advance the REU program. Each breakout group was assigned a unique question related to the theme of the main topic, and open discussion and brainstorming was facilitated by moderators from the Leadership Group. The specific breakout questions were guided by a pre-workshop questionnaire.

Four topics were emphasized at the meeting, with significant outcomes summarized for each:

1) *Highly effective strategies for broadening participation and involvement of underrepresented minorities.*

- Building sustainable bridges between HBCU/MSI programs requires extensive communication and development of shared resources/collaborative opportunities
- The quality of mentorship has an enormous impact on research productivity and the impact on the student.

2) *Evaluation of the REU program as a whole and sharing of most effective practices.*

- There is a compelling need for a centralized, unified assessment tool, as well as compilation of more extensive demographic and tracking information.
- Past REU participants should be utilized as effective resource for future recruitment and justification for the impact of REU programs in general.
- The prestige of the REU program should be more broadly emphasized.

3) *Assessment of the REU Leadership Group*

- The Leadership Group should facilitate communications between PIs, expand efforts to broadcast effective practices of REU programs, increase "marketing" efforts, and champion growth and new initiatives of the REU program.

4) *Incorporating ethics into REU programs.*

- Innovative, transformative ethics training methods that emphasize REU student self-reflection, as well as discussion of case studies, are an integral part of REU programs.

Sponsored by the Chemistry REU Leadership Group

Organizing Committee

Cynthia K. Larive (Committee Chair and Meeting Grant PI)
University of California - Riverside

Tim Hanks (2008 LG Chair and Meeting Grant Co-PI)
Furman University

Jennifer Brodbelt (2009 LG Chair)
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Chemistry REU PI's Meeting

History and Objectives of the Meeting

NSF awarded the first REU grants in 1987 with the goal of increasing undergraduate participation in the research enterprise, particularly the participation of demographic groups that have traditionally been under-represented in the STEM fields. In 1990, and again in 2001, the Chemistry Division held meetings for REU PIs as a way to improve communication between NSF and the undergraduate research community, and to provide direction for the program. These meetings provided an assessment of the key successes of and challenges to the program, as well as recommendations for improvement. Recognizing that the infrequent PI meetings were insufficient to address the issues that had been raised, the second meeting called for the formation of an REU Leadership Group (LG) to spearhead important initiatives to strengthen the program.

In 2008, it became clear to the LG that it was time to report back to the REU community on its activities and to seek guidance as to future initiatives. It was also time for a new generation of PIs to gather to assess the status of the program and how to move it forward. The previous meetings had each identified a variety of topics of concern, but two particularly important issues persisted – that of increasing the diversity of student participants in the program and the methodology of assessing and evaluating the program. A third issue that has become increasingly important since the 2001 is an emphasis of scientific ethics. After surveying the REU PIs, the LG decided that these three themes would form the structure for a third meeting.

The 2009 Chemistry REU PI Workshop was organized to address four critical tasks, including:

- 1) *An assessment of the REU Leadership Group.* Having arisen from the 2001 REU PI meeting, the LG was in its third funding cycle. The group had taken on a variety of challenges and while its central mission of enhancing the Chemistry REU program had not changed, there had been dramatic changes in the projects that the group was undertaking. The LG had been able to justify its existence to the NSF as evidenced by the renewal of its funding, but now the REU Community would formally review the group's activities.
- 2) *An evaluation of the REU program as a whole.* As the program entered its 22nd year, the Community would examine the program's successes and provide guidance as to its future direction. The program PIs are uniquely qualified to take on this task as they interact closely with the NSF, the faculty mentors, and the students.
- 3) *An assessment of efforts to involve underrepresented minorities.* The inclusion of minority populations in the scientific enterprise has long been a goal of the REU program and of NSF as a whole, yet many REU programs continue to struggle to find qualified minority applicants for their programs. The REU community would hear from diversity experts and from those mentoring under represented populations as a way for identifying new strategies for this effort.
- 4) *A celebration of highly effective practices.* The REU program has been extremely successful and the community is dynamic. Each site has activities and events that makes it unique and contributes to the REU mission in its own way. The PIs would celebrate this array of approaches and would gather insights in to the many highly effective practices that have been developed.

Results of the Pre-workshop Questionnaire

To better identify the pertinent issues for discussion during the workshop, a pre-workshop questionnaire was distributed and collected from the participants. The survey is included in **Appendix A**. A total of 55 REU PIs responded to the survey by email.

The questionnaire asked a series of questions designed to probe the demographics of the reporting sites and asked several open ended questions, the results of which were used to refine the breakout group questions. The average length of the reporting REU programs was 8.3 ± 7.7 yr with a range of 1-23 yr. Several long-running programs noted that they had experienced funding gaps at least once in their site's history and several newly funded programs were in their first summer. The percentage of women participants supported over the lifetime of the reporting programs was $54.9 \pm 13.1\%$ with a range of 20 – 78.3%. The percentage of participants over the lifetime of the reporting programs who were members of a group traditionally underrepresented in science was $26.8 \pm 17.6\%$ with a range of 0 – 95%. The site reporting no underrepresented participants was in its first summer and received late notification of their award. PIs were asked how effective they felt their program has been in involving underrepresented students: 20 PIs reported that they were not very effective, 18 PIs reported adequate effectiveness and 17 PIs judged their program to be very effective in recruiting underrepresented students. When asked about their strategies for recruiting underrepresented students, the most common responses were:

- Send fliers, emails, posters, etc. to schools with a large population of URM students
- Contact directors of McNair, HBCU-UP and LSAMP programs to solicit applications
- Advertise at NOBCCChE, SACNAS, AISES and ACS meetings
- Visits by REU faculty to URM-serving schools
- Ask REU students to display their final posters at their home institutions.

In addition to these activities, several additional strategies were reported that could be characterized as having a greater degree of interactivity with faculty and students at institutions with large populations of underrepresented students:

- Discussions with our Advisory Board Member from a nearby URM-serving university
- Establish personal contacts with schools with large minority populations
- Host minority faculty and undergraduates for a visitation weekend to introduce graduate and REU opportunities
- Work closely with teachers at Tribal Colleges to identify promising Native American students.
- Collaborate with regional two-year schools to recruit students to our program
- Visiting Faculty Mentor program – URM faculty member spends summer on campus as a research partner.

In response to the question of whether an REU research experience has a greater impact on some students more than others do, 48 of the 55 respondents responded yes. Those responding affirmatively to this question were asked if there are common characteristics that the most highly affected students possess. The most frequent responses were:

- I have been unable to discern a profile for these student
- Personal motivation and interest

- Age, class standing, socioeconomic factors, home institution, education of parents, high school preparation
- Students from smaller institutions lacking significant research facilities with no graduate program
- Already existing (albeit often dormant) predispositions for research that are unleashed during the REU program.
- Students who are first generation to attend college
- Bright under-achievers who discover purpose and reason during their REU experience.
- Those who have perhaps had less focus in their studies or are unsure of their career goals.

PI's were asked whether they receive support from their department or university for their REU program, with 51 out of 55 responding yes. The most common types of support reported were:

- Administrative support
- Support for additional students
- Housing, tuition and food for the students
- Salary support for the faculty mentors
- Materials and supplies
- Travel costs for REU students to attend the Spring ACS National Meeting
- Funds for team building and social events
- Matching support for director's stipend, stipend for assessment coordinator

The survey also asked PIs about how they assessed the effectiveness of their programs. The most frequent assessment tool reported was they anonymous survey, although web-based surveys, and exit interviews were also prominent among the responses:

- Surveys at the beginning, middle, and end of the program
- Grinnell Survey of Undergraduate Research Experiences (SUREII) web survey
- Student Assessment of their Learning Gains (SALG) web survey
- Students prepare research report
- Exit interviews with director
- Query faculty mentors
- Post-program follow-up, tracking of students
- Outside evaluator

Participants were asked if they were familiar with the REU LG prior to communicating about this meeting, with 26 of the 55 respondents answering yes. When asked about what LG activities the respondents were most familiar with, the participants overwhelmingly recognized the REU student travel awards. Smaller numbers of respondents reported familiarity with prior PI meetings and the project to collect statistics from the sites about the number of applicants to their programs.

Finally, the respondents were given the opportunity to identify what they considered their greatest challenges. The majority of the challenges expressed could be coalesced into the categories program issues related to student recruitment, faculty and program organization, and assessment.

Student Recruitment

- Recruiting of participants from underrepresented groups
- Should we have a national acceptance/application deadline
- No coordination among programs about selecting students, so some students get multiple offers and others get none
- National marketing of the NSF REU brand—to students, educators, parents, employers, host institutions, etc.

Faculty/Programmatic

- Maintaining faculty interest in having REU students in their groups is a significant, important challenge
- How to handle the transition to a new PI
- Inclusion of students from Community Colleges: How to reach them better
- The unique role that PUIs can play in the REU program
- The balance between professional development activities (workshops, lectures, plant tours, etc.) and the primary focus on research.
- What is the optimum diversity of faculty interests to make a cohesive group
- Length of program- it is challenging to run a 10 week program at my university, but my impression was that it had to be 10 weeks to be funded by NSF- more flexibility would be nice

Assessment

- Strategies for long-term follow up and assessment
- Lack of monetary support for assessment is a real barrier to doing good assessment
- Increasing student compliance with maintaining contact for a minimum of five years, possibly a standard evaluation tool
- Publications as an assessment metric. A ten-week program may not be enough to produce enough results for journal publication.
- How to balance a good pedagogical research project with the goal of producing publication quality research? A real research experience often translates into a student being given his/her own piece of a project—instead of working under a graduate student. This does not always translate easily into publications.

These challenges along with the other data culled from the questionnaire were presented to the workshop participants by Cynthia Larive at the beginning of the first full day of the meeting. A complete list of workshop participants is contained in **Appendix B**. The workshop consisted of three sessions, each with two short presentations to motivate the discussions that occurred in subsequent breakout groups. The workshop agenda can be found in **Appendix C** and the speaker biosketches and abstracts are presented in **Appendix D**. Chemistry REU LG members

served as facilitators for each breakout group. A volunteer was selected by each group to serve as the reporter for each group. Breakout group questions and compositions are listed in **Appendix E**.

The meeting kicked off with a poster session and mixer. A list of the posters presented can be found in **Appendix F**. Following dinner, the participants were welcomed by LG chair, Jennifer Brodbelt. LG past chair Tim Hanks, LG past chair gave a brief history of the Chemistry REU program and the Leadership Group. During a working lunch on the second day of the meeting, Dr. Wilfredo Colon, NSF gave a presentation titled "The View from NSF" and answered questions from program participants.

Session I: Strategies for Broadening Participation

Broadening participation has remained one of the forefront issues among PIs as they strive for sustained diversity in their programs, and it continues to be a carefully scrutinized aspect of both renewals and new REU proposals. The success of efforts related to broadening participation and student recruitment also has a direct impact on research productivity and retention of students in science, making it a natural choice for emphasis at the PI Meeting. An entire half-day session was dedicated to this topic, which opened with presentations from two experts sharing complementary perspectives: one with expertise in creating productive partnerships between MSI and non-MSI institutions and effective recruiting practices, and the other emphasizing the significant impact of providing research opportunities for underrepresented students. The presentations were followed by directed break-out sessions covering seven topics related to broadening participation, recruiting, and productivity, aimed at encouraging discussion about the broader impacts of REU programs and establishing sustainable practices to ensure the longer-term success of undergraduate research programs. Several recurring themes that arose from these breakout discussions included the importance of building mutually beneficial alliances with minority serving institutions, the critical impact of mentorship on successful REU outcomes, and the numerous ways that effective practices of REU programs can be translated into other programs. The specific breakout topics and summary of key outcomes are provided below.

Speakers:

Mary Boyd, Dean, College of Arts and Sciences, Professor of Chemistry, University of San Diego

“Broadening Participation in Undergraduate Research: Building Successful and Sustainable Partnerships to Provide Opportunities for Students from Underrepresented Groups”

Michelle Claville, Associate Professor and Chair, Department of Chemistry, Southern University and A&M College, Baton Rouge, Louisiana

“Implementing and Building a Successful REU Program from a HBCU/MSI Perspective”

Breakout Session I. Challenges of Broadening Participation and More Effective REU Outreach: Summary of Topics and Outcomes

Group 1. What are the best predictors for successful outcomes (in terms of research productivity, retention of students in science, matriculation into graduate programs, etc) when recruiting/selecting participants for REU programs and what is the impact on students?

- It must first be recognized that the definition of “successful outcomes” may vary between sites and even among the stakeholders involved in a particular site.
- Many recruited students may not have clear visions for their future career paths. Research experiences can clarify career directions as well as helping students identify options that better fit their interests and professional goals.

- REU programs can have a major impact on the students' interest in pursuing graduate school. There is broad consensus that a good (or bad) REU experience can change a student's decision about continuing on a research track.
- Students may be influenced strongly by family/cultural issues that discourage departure from their home regions.
- A student's GPA is not always the best metric for REU selection. Students that have strong letters of support merit close attention, even with GPAs that might otherwise make them overlooked as the top applicants.
- Mentoring has a huge impact on student success and productivity. Training workshops or modules for new PIs should be developed that provide information about mentoring and effective practices for building successful REU programs.

Group 2. What have been the most effective strategies for broadening participation at your REU site?

- Among REU PIs, there remains the unwritten rule that a successful REU program should consist of 30% underrepresented minorities, although the ability to attain this goal is far easier in certain regions of the U.S. than others.
- Recruitment of non-traditional students, such as those with dependent children, those with disabilities, etc. remains challenging. Few REU programs are equipped to deal with daycare issues and/or have experience with involving students with disabilities.
- The most effective strategies for broadening participation include personalized and repeated visits to MSI schools. The visits should include presentations that are tailored to the targeted audience, and less formal recruiting events, such as pizza parties, are often very successful.
- It is critical to develop sustainable relationships with MSI long in advance of the application deadline. Students from MSI must become familiar with the REU schools.
- Effective recruitment remains one of the most time-consuming issues associated with REU programs. Time, money, and administrative support are critical.

Group 3. What are the impacts and payoffs of involvement of freshman/sophomores and community college students in REU programs?

- The tradeoff between engaging early-stage students and the impact on research productivity remains a difficult issue. Sacrificing productivity at the expense of involving less experienced students is controversial, especially given the current NSF emphasis on productivity.
- REU programs need to establish faculty buy-in by emphasizing meaningful impact and outcomes that can evolve from involvement of early stage students and community college students
- The involvement of freshman/sophomores could strongly benefit from leveraging of support to provide opportunities for student continuation beyond the first program period.
- Involvement of students from community colleges has a tremendous impact on those students and can ease their transition to four-year colleges.

- One benefit of involvement of community college students is that these students can pursue longer-term projects if the students transfer.
- In general, involvement of freshmen students from one's home institution has potentially greater long-term payoffs if the student remains involved in research for multiple years.
- There was interest in pursuing incentives for involving freshmen/sophomore students by encouraging return visits to allow the pursuit of longer-term research goals, although financial costs can become prohibitive
- Allowing faculty to select students from pools of applicants is not productive. It is preferable to pre-match students to faculty mentors to encourage good, lasting matches.

Group 4. What are the most effective strategies for building sustainable bridges between HBCU/MSI programs?

- To solidify relationships with MSIs, REU programs should reserve spots for students from the targeted MSIs. This establishes a true alliance between programs and builds confidence in MSI faculty about the sustainability of the partnerships.
- Non-research MSI should not be overlooked because these schools have many students with no research opportunities.
- Establishing alliances with MSIs requires regular and frequent interactions.
- Some MSIs have records of retaining their best undergraduates students for masters degrees and are not good candidates for balanced partnerships with REU programs.
- The most successful bridges to MSIs focus on building partnerships with faculty for long-term success.
- Successful partnerships might include the development of monthly seminar programs on professional development at local MSIs, or regular use of shared instrumentation. Major institutions may provide access to equipment, or expertise, or some other service such as glassblowing. MSIs might also provide expertise on teaching, or web-based learning, etc.
- Clarify expectations of what can be accomplished during an REU (unrealistic expectations of obtaining a cure for cancer or publishing a paper after 10 weeks of research can cause problems: avoid "pie-in-the-sky" problems that lead to disappointment and sense of failure). Educate MSI faculty to identify students who are not having significant outside-of-school problems that would prevent student from devoting full time to 10-week research experience.
- Local/regional recruitment has greater chances for success.
- A "Clearinghouse" mechanism for circulating applications from non-accepted, qualified students (i.e. overflow students) should be established to match non-accepted students with vacancies in REU programs.
- Overly aggressive recruitment of students from an MSI that results in a large number of viable applications can result in loss of credibility of an REU program when only a few (or one) students can be accepted. Qualified applicants who are not selected could be referred to other REU sites: particularly newly funded REU sites who have not had the lead-time to carry out an in-depth recruitment for under-represented participants. To avoid legal implications of sharing applications, one could add a sentence on the application form asking if the applicant would be willing to have his/her application materials shared with other REU programs if the original REU

program is unable to make an offer. Another option discussed is a joint application with a regional focus for several REU programs, in which applicants would rank their choice of institutions.

- It is critical to communicate back to Letter of Recommendation (LOR) Writers to convey respectful appreciation for identifying and encouraging student applications
- Successful REU programs send letters of appreciation to LOR writers and to actual participants on official letterhead, valuing the student's participation and achievements.
- For any successful REU program, the expectation of faculty mentors and students must be clearly stated early and continuously.
- If faculty from MSIs visit an REU site for the summer, make it clear that this is a full-time commitment, and that the visiting faculty should not be concurrently teaching at their home institutions during the 10-week REU period. Develop projects that the visiting faculty can pursue collaboratively in the future, once the faculty has left the REU lab, to sustain the interactions.
- Sustained communication with MSIs (pre-program, during program, post-program) is critical for success.

Group 5. How can REU practices be translated into broadening participation along the pipeline (graduate education, academics careers)?

- It is highly recommended that a better tracking mechanism for following the future outcomes of REU students be developed. In general, more extensive longer-term student tracking information is needed.
- Students should be exposed to the pro's and con's and time commitment of all career tracks.
- The emphasis on productivity measured by publications remains controversial.
- All REU programs should make students aware that graduate programs in the sciences provide stipends
- Interactions between REU participants and minority graduate students should be facilitated via near-peer mentoring. Regional Facebook pages for institutions without a substantial minority graduate student population could be one way to pursue this idea.
- More extensive long-term mentoring that utilizes electronic resources should be developed.
- At the end of an REU program, students should be able to articulate answers to the question "What new knowledge have you generated during your REU project?"
- In general, peer mentoring is an attractive and viable option. Successful REU participants are an outstanding and under-utilized resource.
- It was noted that the annual convention of LSAMP members brings many students together. LSAMP programs may serve as excellent places for targeted recruiting to other parts of the pipeline

Group 6. What are the best practices for insuring research productivity in REU programs?

- Quantitative metrics for assessing student accomplishments and self-confidence are needed.
- The quality of mentorship is critical but frequently under-emphasized in REU programs.
- It should be noted that not all faculty make good mentors. Faculty mentors should be selected as carefully as are student participants.
- Students should be taught the art of giving short, impromptu talks that emphasize the broader goals of their projects.
- The creation of formal research reports by the students can help a student's work eventually be incorporated into submitted papers.

Group 7. What are the most significant hurdles faced when broadening participation in REU programs?

- Attracting minorities students in some regions of the U.S. remains very challenging.
- The prestige of REU support needs to be emphasized so that students see the greater benefits of REU programs (networking, experience, personal and professional development, more than just a paycheck) in comparison to other employment opportunities.
- There was broad consensus for using common application deadlines for REU programs to prevent escalating competition between programs for securing the “best” students and/or underrepresented students.
- It was recognized that REU-alums are a great exploitable resource to facilitate recruitment.

Suggested action items

- Assemble PI/mentor training materials available to new and future PIs to assist in establishing successful REU sites
- Offer regional workshops or ones tied to ACS meetings on the topic of broadening participation and effective practices for establishing partnerships with MSIs
- Establish better connections between REU programs through creation of a Facebook forum
- Develop more extensive REU student tracking system to obtain quantitative data about the future educational and career paths of REU participants.
- Develop strategies for exploiting REU alums to assist in expansion of REU programs, recruitment, etc.

Session 2: Evaluating REU Sites and the REU Program

All Federal programs are ultimately responsible to the taxpayer for the way in which their supporting funds are used. REU Site Directors must be able to show that their activities are of value to the program participants and to the scientific enterprise. The REU program as a whole must show that it is having a positive impact on future chemists. The evaluation component of a program is always a challenge for PIs as they are scientists rather than evaluation specialists. In addition, there are a number of stakeholders who would like additional information for different purposes. Their requests for data must be balanced against the student's right to privacy and their willingness to spend time honestly contributing to the assessment. Two assessment experts provided insight into some of the issues facing directors of undergraduate research programs. Sandra Laursen presented a flexible evaluation tool that might be a starting point for creating a standardized assessment protocol for the entire chemistry REU program. Cecile Brookover illustrated strategies for developing effective evaluation questions. Together, the speakers challenged the group to think about the design of better evaluation tools for both individual sites and potentially for the larger REU program. These topics were addressed in seven breakout sections that resulted in a clear mandate from the group to explore the development common assessment tool. The groups also noted a need to look at ways to track REU participants over a longer time period.

Speakers:

Sandra Laursen, Co-Director of Ethnography & Evaluation Research, University of Colorado at Boulder

“URSSA: A research-grounded tool for assessing student outcomes of REU programs”

Cecile Brookover, Assistant Professor, Department of Psychology, Xavier University of Louisiana

“Intro to Program Evaluation Assessment: New or Existing Measures?”

Breakout Session II: Evaluation Tools and Strategies

Group 1. What are the pro's and con's of a Common Evaluation Tool?

Pros of a Common Evaluation Tool:

- A common assessment tool would reduce the time required to produce a quality program assessment at each site. However, the tool must be modifiable to fit the unique requirements of each program.
- A common tool could provide both NSF and the REU Community with hard statistics on critical program parameters, such as applicant demographics, demand for opportunities and others. This might be useful for directing resources both nationally and at individual sites.
- A centralized assessment tool would permit PIs to compare the performance of their site to that of the program as a whole. This could produce objective measures of success and alert PIs to problems that might not be recognized from an isolated perspective.

- A centralized assessment tool might serve as a platform for longer term tracking of participants as a means of better measuring the impact of the REU program.

Cons of a Common Evaluation Tool:

- The design of a universal tool may be very challenging due to the great diversity of programs within the REU program. Creating the tool might be expensive.
- There may be a tendency to use the data collected by a tool to inappropriately compare programs. There are large differences between PUIs and R1 institutions in terms of the expected research output and possibly the types of support programs available. There are also large differences in the opportunity to recruit under represented students in certain geographical areas.
- Many aspects of a program are difficult to quantify or even define in a common tool. Failure to appreciate this could lead to misuse of the data to the detriment of a program.

Group 2. If a Common Evaluation Tool were to be adopted, what should it assess?

- Assessment should track change in the student with time. Students come in at different levels, and will leave at different levels. In order to get complete picture of the impact of a program, assessment of some kind should take place at the beginning, middle, end, and some time after the end of the research experience.
- Assessment should consider student impressions, including their sense of community in the program, perceived barriers to their future as scientists, and the effectiveness of their research mentors. Post-experience assessment may help assess the impact of these impressions on a student's career path.
- A scientist requires a diverse skill set, including communications skills and laboratory technical skills. A common evaluation tool should probe the development of basic skills over the course of the experience.

Group 3. What assessment data do Site Directors need?

- Answering this question first required an understanding of how site directors use assessment data. This varies enormously, but includes real-time monitoring of students to detect critical problems in their personal or laboratory situations, longer term evaluation for improving the program, and the development of a project profile for grant reporting and renewal applications.
- Data that are of broad interest to site directors include:
 - Measures of student learning gains and laboratory progress.
 - Student satisfaction with programmatic features and professional development.
 - Improvement in specific skills, including technical reading comprehension and laboratory techniques.
 - Measures of program productivity, including publications and presentations as well as the creation of protocols that impact a laboratory over the long term.
 - An assessment of the program mentors and their impact on the student's scientific development.

- Site directors want a holistic view of their programs and often need data that are unique to their sites in order to assess local goals and programmatic features. They also want assessment tools that are easy to implement so as not to interfere with their programs. Finally, the assessment of the impact of a program would be easier to determine with an appropriate control group, but this is rarely possible.

Group 4. What assessment data would be most convincingly justify the value of the REU program to policy makers or the public?

- The value of the REU program would be most clearly illustrated by data that showed differences between the career paths of REU participants and valid control groups that had non-REU research experiences, or no research experience at all. Currently, there is anecdotal evidence that the REU program has a positive effect, but this is extremely difficult to quantify. Related data that would be of value would include information on the relative graduate school performance of these groups.
- The economic impact of the program would also make a useful argument. This would include the immediate impact due to expenditures to support the laboratory work and the longer-term impact from the discoveries generated by the research.

Group 5. What student demographics are most impacted by a research experience? How do we know?

- This question cannot be conclusively answered without a large and detailed data set, however it is logical to assume that the most highly impacted students will be those that have no opportunity for research and/or limited research infrastructure at their home institution.
- Some proponents suggest that research will have a larger impact when experience earlier in the student's academic career. However, it is also recognized that the nature of the experience will change with the students incoming experience.
- Another difficulty with this question is the definition of "impacted". A research experience may provide very different influences upon different populations and these may often be either "good" or "bad" base upon the perspective of the observer. For example, if a student decides to go to chemistry graduate school, this might be viewed as a positive impact. However, if a student decides that a career in science is not right for him or her, this might also be a positive impact.
- It would be desirable to better understand the impacts of research on various demographic groups. In particular, the role of the student's socioeconomic background, age, and many others.

Group 6. Is a REU experience a cost effective way for students to gain research experience?

- The experience can be very cost effective for NSF, particularly when cost sharing by the institution and leveraging of the experience of existing laboratory personnel and facilities are considered. The cost effectiveness is less clear for students from R1 institutions, as they may be able to participate in an experience in an existing program.
- There are many approaches that might extend the cost efficiency (to NSF at least) of the REU program. These include: 1) Regional models that minimize transportation costs and

may have additional impacts on non-host institutions in the area; 2) Maximizing impact by generating co-sponsorship from industry or other Federal programs such as the URC program or PIRE; 3) Developing time-extended programs that combine a summer program with a fall term research/classroom program.

- Ultimately, the question is not so much the cost efficiency of the REU program for providing a research experience, but the value of the experience as determined by the various stakeholders.

Group 7. How can we get a global view of the impact of the REU program?

- The answer to this question requires an inventory of the stakeholders that are affected by the program. In addition to the student participant, there is an impact on the mentors and others in the host laboratory, on both the host and home institutions, graduate programs (and other institutions) that eventually accept the REU alumni, and those impacted by the scientific output of the REU program.
- One of the most important outcomes of the REU program is the impact on the number of students who go on to attend graduate school and the effect that the REU experience has on the student's graduate school performance.
- An impact that has not been evaluated is that on the student's home institution. The research experience of one student may encourage other students into STEM fields, to consider gaining their own research experience, or to go on to attend graduate school. There may also be an impact on the faculty and research infrastructure at these institutions.
- An REU program can be a benefit to the host institution. At PUIs in particular, the REU may form the core of a larger undergraduate research program and the activities (invited speakers, social events, etc) can impact many students that are not formally part of the REU program. The presence of undergraduates in laboratories at R1 institutions offers mentoring opportunities for postdocs and graduate students that might not otherwise exist.
- There is a need for long-term tracking of students in order to gather these data. Key life experience times would include the point where students:
 - Enter graduate or professional schools
 - Finished grad school
 - Find their first employment
- Some relevant data may come from questions placed by the LG on the ACS survey of undergraduate degrees, but new tracking methods will be required for a global view.

Suggested action items

- The group overwhelmingly recommends the development of a common evaluation tool, possibly from a centralized location to allow for cross-program statistical analysis. This tool must be carefully constructed to allow flexibility to meet the diverse needs of sites and the data analyzed in ways that respect both the student participants and the sites.
- Methods should be developed to enable tracking of students over extended time periods. The impact of an REU experience cannot be fully understood until years after

the event. Ideally, data collected on control populations would also be collected. The group recognizes the challenges implicit in this recommendation.

Additional assessment activities should be undertaken that highlight the impact of the REU program on other stakeholders besides the students. The LG might be a group that could collect such data from a position of legitimacy and then be in a position to disseminate those results.

Session III: The Ethics Component of REU programs and Development of an Action Plan and the Role of the Leadership

Ethical Behavior in Science

Principal investigators (PI) often have little formal training in the teaching of responsible conduct of research, also known as the “ethics component” of an REU site. Due to a number of factors, group discussions of case studies have been utilized as a method of teaching the ethics component, mostly because it is an easy way to get students involved in the issues. However, it has been found that a good case discussion is not the same as dealing with a real ethical problem, where it is simply an approximation of such an experience. In fact, feedback from several REU site suggests that case studies have some value, but that students get bored quickly, and the immediate objective of learning new habits of responsible (ethical) conduct of research is not be made with the students. Consequently, a new pedagogical approach is needed, one beyond the current resources, time, and experience of the typical REU PI. To assist PIs in enhancing the ethical component of their REU site, Prof. Robert Skipper and Prof. Gloria MaGee were invited to speak at the PI Meeting. Prof. Skipper academic research is focused upon making ethical behavior a more relevant experience for the student in science. Prof. MaGee has developed an extensive case study approach, which has been successful with REU students. The Friday session started with sixty minutes, where Prof. Skipper spoke for 35 minutes and Prof. MaGee spoke for 10 minutes. There was 15 minutes reserved for questions and comments, since this topic did not have an associated breakout session. Prof. Skipper outlined a new pedagogical tool to assist students to become more self-aware, observant, reflective, and attain a deeper appreciation of others that may be affected by their decisions. Prof. MaGee introduced the Poynter case studies, and how method evolved beyond simple case studies to engage the students. Overall, the session was well received by the audience, which seemed to inspire many PIs to make the “ethics component” more relevant and meaningful for the student.

REU Ethics Component Speakers:

Robert Skipper, Chair and Professor, Department of Philosophy, St. Mary’s University, San Antonio

“Exploring Ethics for Undergraduates”

Gloria Thomas Magee, Assistant Professor, Department of Chemistry, Xavier University of Louisiana

“A Chemist’s Start in Ethics and Engaging Undergraduates”

Summary

- Case studies are easy and should be the minimal exposure for an ethical component. There are other methods that should be explored to make exposure to ethical issues more relevant to the student.
- Good case discussion of ethical issues is not the same as dealing with a real ethical problem that the student may have to confront.

- Have students keep an ethics notebook, which may be separate from the laboratory notebook, where they record their observations of their decisions. Over the 10 weeks, greatly improved observations should be made.
- The research mentor should periodically check the notebook, and ask the student how his/her decisions affected others (reflection). Reflection should also mature significantly over the 10-week experience.
- Famous case studies do not necessarily catch the interest of students. Students do not (rightfully so) see the connection to their experience in the laboratory. The Poynter cases target more immediate and plausible situations that the student can make a connection and see the relevancy.
- Lectures or talks on case studies are not the path to take to engage students. Small groups discussions improves the value of the experience. More creative avenues, such as role-playing, seemed to be most effective with the students allowing the students to see certain and alternative perspectives.
- There was some discussion on whether the “laboratory” notebook should have “ethical observations”. Prof. Skipper suggested two separate books. The argument was that the research notebook is a legal document and that ethical observations would not be appropriate.

Action Plan and LG Role

In order to capture the main ideas and needs of the REU community, a final breakout session on developing an action plan and the role of the LG was carried out. This breakout session directly followed the lectures on ethics, but really of the lectures and topics formed the basis of the breakout groups. The breakout sessions covered seven topics related to the development of an action plan and role of the Leadership Group. Several recurring themes that arose from these breakout discussions included the importance of the LG and how it should facilitate communication between PIs and with the NSF, the significance of the website (www.nsf-reu.org) and content that could be used (not mandated) to the benefit of all sites, and the importance of modulating the time of research experience and the length of awards. A few of the critical issues facing the REU program involved the stability of the rotator program director position (5 years, 5 different PDs). Uniformly, the PIs expressed concern that the NSF expects to fund these sites on a shoestring budget. The experience should be about quality, and has shown by previous statistics it should be about quantity as well. The specific breakout topics and summary of key outcomes are provided below.

Breakout Session III: Development of an Action Plan and the Role of the Leadership Group. Transformative Ideas for the Future.

Group 1. Define the role/mandate of the Leadership Group. Should the Leadership Group be an influencer, mediator, or enabler of the REU Chemistry community?

- One critical role of the LG is to provide the bridge between different generations of REU sites, which have reported lifetimes between 2 to 3 renewals, and switching of rotating program directors, which as occurred four times in the last four years. Thus, the LG should:
 - Assist NSF director toward achieving the goals of the program. The LG could assist by providing an historical perspective, or by indicating the needs/wants of

the REU community. For example, it was been suggested that there is a need for assessment or broadening the participation of students at REU sites.

- Serve as the communication between PIs and the NSF director to bring news to/from the REU community. Such as, express concern concerning the late announcement of awards from the community, or the explanation from the NSF concerning the lateness of awards.
 - Act as a community memory and avoid having to recreate the wheel and possible pitfalls. It has been suggested that the LG formulate a “manual” for new REU PIs and new program directors.
 - Carry out putative roles, expressing the wishes of the majority of the REU community. For example, deal with the deal controversy of common application deadlines.
- A second critical role of the LG is to facilitate communications between PI's. For example, alert PIs to discussion topics/issues, provide information for ethics, consult with PIs for effective leadership when deemed appropriate by LG.
 - Act as an enabler; e.g. facilitate application sharing, effective practice methodology. The effective practices should not be mandates, rather offered and used as needed by individual REU sites.
 - Provide a forum for discussion, since there is no formal method to share knowledge on running or maintaining an REU site.
 - Choose when it is appropriate to have a meeting, telecom, or workshop, and the frequency at which each is carried out.
 - Arrange the possibility of having a REU PIs forum once a year at ACS meeting to encourage face-to-face meetings of REU PIs, such as an organized poster session.
 - A third role of the LS is to suggest having a regular conference, as appropriate, as determined by feedback from the REU community or changes at the NSF.
 - Serves to transfer knowledge from experienced to new members. Every three years was suggested, dependent upon the length of current REU grants.
 - Address active problems which may have arise due to year by year, or problems of more chronic nature.
 - Provide workshops as needed by the community. For example, now that the NSF wants a different type of ethics exposure beyond that delivered by “case studies,” it seems that intervention via a workshop for those interested would be welcomed.

Group 2. Evaluate the effectiveness and utility of the Leadership Group website. What additional tools/information should it offer? Would Facebook/listserves or discussion board be beneficial?

Summary: The current LG group website is a good start and should be expanded

Roles of the LG website

- PIs need assistance in getting their sites started. In many situations, the PIs do not have an easy or convenient source of information. Thus, the LG website can be a common ground, or portal for PIs and aspirational PIs.
- In many ways, the website can be used to introduce the LG and its function to the community. It is at the website that the LG can define the role of the LG.
- Provide links for students linking to new sites. To help students, a common one page description of sites can be offered. Currently, the NSF portal does not provide information about new sites in a timely way.

Tips for PIs. (Provide tips for running programs – not for writing successful proposals)

- Have a box on your application where students can check if they will allow their application to be shared with other programs. Thus, allow for application sharing of students.
- Documents can be made available to provide guidance for the of mentoring students. It was expressed that there are many common situations that arise frequently. It would be helpful to know what to expect and how others resolved the issues.
- Downloadable documents and sharing of links to resources could be made available, so that the most relevant sources are available to REU PIs.
- Sometimes it is useful to interface with other PIs that experience the same issues. It might be helpful for a discussion board which is open only to PIs.

Tips for students

- It would be helpful to give students helpful hints on increasing their chances on being accepted to an REU site. The helpful hints may help the student in application ethics. The student should not accept more than one position, and honor decisions made.
- Some students operate in a vacuum and do not have the opportunity of a good mentor. As such, one of the main flaws is in asking the right reviewers for letters. Topics such as identifying good letter writers will assist students.

Aesthetics

- To make the website attractive and easy to read, it is suggested to keep pages short and descriptions concise.
- Create LG Facebook page. Individual REU program pages can become fans of the LG page and therefore linked.

Recommendation – establish a LG task force for web development

Group 3. How should REU sites utilize current technologies to be more effective?

- Disadvantage of Facebook – they own anything posted on Facebook and retain the legal rights to the content forever.+
- Assessment for individual sites are done much differently. A common assessment tool would allow for a larger more grand assessment that could be used to justify funding and expansion of the REU program. Furthermore, PI's that are not formally trained on assessment (probably 100%) could focus more on the research experience.

- The creation of an applicant pool clearing house would assist sites who get late notice or need to backfill for a late withdrawal. This would assist sites, but also generate valuable opportunities for the students.
- It would be desirable to have more searchable structured database for REU applicants. NSF database is limited in its utility – not deeply searchable. Pointers from ACS and CUR website to lead students to the site. Options for regional, disciplinary, and accommodation for specific disabilities could be appropriate flags. Speakers bureau, perhaps with LG proposal to help fund limited speaker travel. Cost of trip could be leveraged if it was used as a component of a graduate recruiting trip
- Instrumentation collaborations would assist the productivity of many REU sites. In many cases it is not necessary to have “hands-on” time on machines. Many have “on-line” capabilities. It is suggested that lists of sites holding instrumentation (and regional location) be built and shared with the community. If there is remote access that would be helpful too.

A map of where REU students come from will help identify student populations who are being missed and possibly assist in providing justification for building REU capacity at NSF.

Group 4. Define ideal REU sites of the future. Think out-of-the-box without limitations or constraints?

- Make the experience longer – 12 weeks plus follow up during the academic year, possibly even an extra semester (exchange program) for more meaningful research experiences and increased productivity. Furthermore, longer experiences would make it easier to take younger students.
- Involve faculty at student home universities in research collaborations, promote research at smaller schools, take faculty-student teams and pay both faculty and students beyond the 10-week experience. Encourage and motivate faculty by providing release time from difficult teaching loads.
- Ideal REU should have a budget for student travel to regional and national meetings to present their research. This will help continue research beyond the summer time frame and increase the productivity of the student and site.
- Bridge research experience for students so they can gain an appreciation for research on a longer timescale and think more deeply and critically on a specific research problem. This will provide better training and productivity.
- Ideal sites should have well-defined and different objectives. Such as, turn students on to research (or at least enriching experience) diversity, recruit student to graduate program, etc. Different tracks within the REU will serve different purposes making the program more diverse. There should be different metrics on gauging success of different types of sites
- One new idea was to create a possible two-year program that leverages funds from DUE. For example, DUE funds freshman, where CHE funds second year.
- More deliberate preparation for (first time) faculty and graduate mentors. Call it orientation, brainstorming, clarifying expectations, etc. Mentoring mentors.

Group 5. Develop a five-year action plan for the NSF REU program

- Build capacity at NSF for REU in terms of acquiring more funding opportunities. Frontloading agreements between other funding organizations, possible DUE co-funding. Don't want to infringe on single investigator grants to fund more sites.
- If we had more funding, it should be spent on more sites with 8-10 students. If possible, longer terms (5 year grants instead of 3 year grants) but would not like to see this at a cost in terms of the number of sites
- Importantly, it is necessary to gain more stable term for rotators. There is a huge learning curve for new directors and unnecessary consternation occurs. The date of award notices is attributed to changes in the director position.
 - LG role in the five-year plan is to share effective practices, keep diversity of the REU programs, and retain balance between frequency and cost of PIs meetings.
 -
- How to express REU value? Look at the outcome of the undergraduate experience if the REU program did not exist. Create a common tracking system to follow students and provide useful and quantitative data on the value of an REU experience.

Group 6. What tools, programs, and opportunities should the Leadership Group offer to support and enhance the REU community? (travel grants, seminars, ethics, advertising, annual workshops on various topics....)

- It is important that the LG become involved in data collection and sharing of information. It would share REU PIs time (and generate more useful data) if there was a common assessment tool (sharing of pooled data). All of data collection stems from the lack of a good way of tracking students. Better tracking would also assist NSF in justifying the program. Among other data sharing the following would be useful:
 - Sharing of best practices/resources among new and future PIs
 - Downloadable ethics/career/mentoring/grad school PPU, worksheets, etc.
 - List of links to useful resources (ethics presentations, potential seminar topics)
 - Develop and distribute "Effective Practices" packet available for all PIs
- The LG could also foster increased communication between sites and with the NSF by having more PI meetings every three years. In addition, each meeting could have a different format, by including more (20-30), shorter (3 min) "best practice" presentations by the PIs, and two poster sessions with one-half staying at their posters.
- Electronic communication could be improved with quarterly email with news and list of updates to website. Other options could include a discussion board.
 -
- Consider "regional" conferences so that instrument sharing and coloration would be promoted. Regional activities are more cost-effective and easier to plan.
- Development of other funding sources by taking approaches to industry (include industrial chemists (preferably former REU students) on the LG). Furthermore, expand and continue the travel award program.
 - The LG and NSF should do a better job in marketing the REU program. The prestige of becoming an NSF REU student is recognized by graduate schools,

but not necessarily by the undergraduate community. Develop generic (non-site specific) REU promotional materials that PIs could use for recruitment visits.

- Support and promotion of PIs (e.g., letters to chairs/deans) Increase the value of being a PI. This would promote the program as well as the program directors/PIs. This could also help with sustaining matching contributions from deans/departments

Group 7. What are the most critical issues facing REU programs that need to be voiced?

- It was repeatedly voiced that REU sites are run on skeleton budgets. Understandably, this is done to expand the program to as many students as possible. It is questioned if the dilution in funding is comprising the experience. Consequently, funding is a critical issue. It was also expressed that the LG and program director need to be more proactive of effective in being better advocates on behalf of all REU sites. In some fashion, the unfilled demand, and the impact needs to be communicated to decision makers at the NSF or in government.
- A growing concern among many PIs is the NSF late notification of awards. The timing is impacting minority recruitment.
- There needs to be an increase in the efficiency of programs. Some features will allow for a more effective and efficient program. For example, the use of a boilerplate language for sharing applications, common calendar, common assessment, or common data base for tracking data. Involvement of ACS, can survey of chemistry undergraduate degrees include a question about REU experiences?
- The NSF provides a lack of accurate, up to date website listing all REUs (including dates). The LG could provide such information.

Suggested Action Items

- The LG should assist NSF program director by providing valuable two-way communication between the community and the NSF, and as advocates for the REU program.
- The LG should facilitate communication between individual PI's. For example, alert PIs to discussion on important topics/issues.
- Improve tracking through Facebook is a possibility, but needs to be fully vetted before adopting. A better solution for communicating is to implement a list serve.
- Develop and distribute "Effective Practices" packet available for all PIs. This will serve to improve the quality of research experiences for the students and should impact the productivity of the REU sites.
- The website should list links to useful resources. The links could target both students and PIs.
- It is understood that meetings take money. There was an over feeling that a decade between meetings was too long. It was suggested to increase the frequency of PI Meeting Workshops (every 3 years).
- The prestige of the REU program needs to be better marketed. The LG or NSF need to develop common recruitment/promotional materials.

- Recruitment seems to be an issue with several sites. A common application, possible clearinghouse of applicants was suggested to alleviate the problem.
- A growing concern was with the application deadline. The date seems to be creeping towards earlier dates to get earlier commitments from students. It was suggested that a common application deadline (maybe a window?) be considered.
- For the sake of improving the quality of individual REU sites, and the REU program overall, it was suggested to develop a common assessment tool.
- Finally, to allow principal investigators to focus upon the training and research with students, it was recommended that a common database for tracking of students should be developed.

References and Resources

www.nsf-reu.org

Resources for Broadening Participation

A Bridge for All: Higher Education Design Principles to Broaden Participation in Science, Technology, Engineering and Mathematics. San Diego, CA: BEST; 2004.

www.bestworkforce.org

“Broadening Participation in Undergraduate Research: Fostering Excellence and Enhancing the Impact” M.K. Boyd and J.L. Wesemann, Eds. Washington, DC: Council on Undergraduate Research; 2009.

<http://www.cur.org/publications/broadening.html>

Resources for Assessment

www.sagepub.com – search for *Program Evaluation Kit* – a set of 10 books on all aspects of program evaluation - \$248

<http://www.the-aps.org/education/promote/promote.html> *Planning an Effective Program Evaluation: Resources for Project Directors* - free

<http://www.nsf.gov/pubs/2002/nsf02057/nsf02057.pdf> - *NSF Handbook for Project Evaluation 2002* – free

Undergraduate Research Student Self-Assessment tool:

<http://spot.colorado.edu/~laurson/accessURSSA.html>

Appendix A

REU PI's Pre-Workshop Questionnaire. Please return by email to clarive@ucr.edu by June 29, 2009

1. Are you attending the REU PI workshop July 8-10 in San Antonio, TX? Yes No
2. Do you have any dietary restrictions? Yes No
If yes, please list:
3. Will you be presenting a poster? Yes No
If yes, please provide a title:
4. Number of years your program has been in existence _____
5. How many REU participants has your program served since its inception? _____
6. How many participants have been women? _____
7. How many participants have been members of groups traditionally underrepresented (African American, Hispanic/Latino, Pacific Islander) in STEM fields? _____
8. How effective do you feel that your program has been in involving underrepresented students?
 very effective adequate not as effective as I would like
9. What do you do to recruit underrepresented students for inclusion in your program?
10. Is it your sense that an REU research experience as a greater impact on some students more than others?
 Yes No
If yes, are there common characteristics that the most highly affected students possess (e.g., age, class standing, socioeconomic factors, etc.)?
11. Do you receive support from your department or university for your REU program?
 Yes No
If yes, describe the support:

12. In your opinion, what are the 3 most important student outcomes of a successful REU experience?

1.

2.

3.

13. How do you assess your program now?

14. What are the strengths of this evaluation strategy?

Weaknesses?

15. Were you aware of the REU Leadership Group before receiving an invitation to attend this workshop? Yes No

If yes, was there a particular aspect of the LG activities you were familiar with?

16. What challenges do you see for your site, and for the REU program in general, that you would like to see discussed at the REU PIs workshop?

Thanks for your input! We look forward to seeing you in San Antonio.

Appendix B

Chemistry REU PIs Meeting Participants

Peter Armentrout	University of Utah
Aravind Asthagiri	University of Florida
Bruce Ault	University of Cincinnati
Denise Bale	University of Washington
Jeanne Basom	University of Oregon
Robert Bateman	University of Southern Mississippi
Eugene Billiot (LG)	Texas A&M Corpus Christi
Maggie Bobbit Bump	Virginia Tech
Cecile Brookover*	Xavier University of Louisiana
Mary Boyd*	University of San Diego
Rebecca Braslau	University of California - Santa Cruz
Jenny Brodbelt (LG)	University of Texas - Austin
Banita Brown	UNC Charlotte
Kenneth Brown	Hope College
Christian Brückner	University of Connecticut
James Brozik	Washington State University
Michelle Claville*	Southern University and A&M College
David Collard	Georgia Institute of Technology
Wilfredo Colon*	National Science Foundation
John Dighton	Rutgers Camden-Pinelands
Lisa Dorn	University of Wisconsin - Oshkosh
Daniel Downey	James Madison University
Daniel Dyer	Southern Illinois University Carbondale
Jeff Evanseck (LG)	Duquesne University
Fillmore Freeman	University of California - Irvine
Brian Frost	University of Nevada
Holly Gaede	Texas A&M University
Robin Garrell	University of California - Los Angeles
Alan Gegenbach	University of Wisconsin - Eau Claire
Arne Gericke	Kent State University
David Haines	Wellesley College

* indicates speakers

LG indicates Chemistry REU Leadership Group Member

Tim Hanks (LG)	Furman University
Karl Haushalter	Harvey Mudd College
Joseph Heppert	University of Kansas
John Hoberg	University of Wyoming
Elon Ison	North Carolina State University
Ben W.-L. Jang	Texas A&M Commerce
Evgenii Kosliak	University of North Dakota
Tom Krugh	University of Rochester
Sarah Larsen (LG)	University of Iowa
Cynthia Larive (LG)	University of California - Riverside
Sandra Laursen*	Colorado State University
Susan Lever	University of Missouri
Gloria Magee* (LG)	Xavier University of Louisiana
Brad Miller	American Chemical Society
Katrina Miranda	University of Arizona
Scott Nickolaisen	California State University Los Angeles
Abby Parrill	University of Memphis
Jonathan Parquette	Ohio State University
David Paul	University of Arkansas
James Penner-Hahn	University of Michigan - Ann Arbor
Robert Petros	University of North Texas
Amy Prieto	Colorado State University
Mike Pullin	New Mexico Institute of Mining and Technology
Peter Qin	University of Southern California
Karin Ruhlandt-Senge	Syracuse University
Robert Skipper*	St. Mary's University
Garon Smith	University of Montana
David Spivak	Louisiana State University
Gary Sulikowski	Vanderbilt University
Sankaran Thayumananava	University of Massachusetts - Amherst
Julio Turrens	University of South Alabama
Hongtao Yu	Jackson State University

** indicates speakers*

LG indicates Chemistry REU Leadership Group Member

Appendix C

NSF REU Chemistry PI's Meeting

July 8-10, 2009 Drury Plaza Hotel Riverwalk, San Antonio, TX

Wednesday, July 8

4:30 - 5:30 PM **Registration and Badge Pickup**

5:00 - 6:30 PM **Poster Session/Mixer**

6:30 - 7:30 PM **Dinner**

7:30 PM **Welcoming Remarks and Overview of LG History and Activities** (Tim Hanks, Furman University, REU LG past-chair and Jenny Brodbelt, University of Texas at Austin, REU LG chair)

Thursday, July 9

7:45 - 8:15 AM **Summary of Pre-meeting Survey Results and Overview of Meeting Agenda**
(Cindy Larive, University of California - Riverside)

8:15 - 9:00 AM **Short Presentations: Strategies for Broadening Participation** (Moderator:
Jenny Brodbelt, University of Texas at Austin)

Mary Boyd, Dean, College of Arts and Sciences, Professor of Chemistry, University of San Diego

“Broadening Participation in Undergraduate Research: Building Successful and Sustainable Partnerships to Provide Opportunities for Students from Underrepresented Groups”

Michelle Claville, Associate Professor and Chair, Department of Chemistry, Southern University and A&M College, Baton Rouge, Louisiana

“Implementing and Building a Successful REU Program from a HBCU/MSI Perspective”

9:00 to 9:15 AM **Instructions for Breakout Session I** (Jenny Brodbelt, University of Texas at Austin)

9:15 – 10:30 AM **Breakout Session I: Challenges of Broadening Participation and More Effective REU Outreach**

10:30 – 10:45 AM **Coffee Break**

10:45 – 11:45 AM **Breakout Session I Reports** (Moderator: Jenny Brodbelt, University of Texas at Austin)

11:45 – 1:15 PM **Working Lunch**
“The View from NSF” Wilfredo Colon (NSF REU Program Director)

1:15 – 2:00 PM **Short Presentations: Evaluating REU Sites and the REU Program**
(Moderator: Tim Hanks, Furman University)

Sandra Laursen, Co-Director of Ethnography & Evaluation Research, University of Colorado at Boulder

“URSSA: A research-grounded tool for assessing student outcomes of REU programs”

Cecile Brookover, Assistant Professor, Department of Psychology, Xavier University of Louisiana

“Intro to Program Evaluation Assessment: New or Existing Measures?”

2:00 – 2:15 PM **Instructions for Breakout Session II and Coffee Break** (Tim Hanks, Furman University)

2:15 – 3:30 PM **Breakout Session II: Evaluation Tools and Strategies**

3:30 – 4:45 PM **Breakout Session II Reports** (Moderator: Tim Hanks, Furman University)

5:00 – 5:15 PM **Overview of NSF REU Travel Awards Program** (David Haines, Wellesley College)

5:15 PM **Conclusions, plans for Friday and suggestions for dinner** (Cindy Larive, University of California - Riverside)

Friday, July 10

8:00 – 9:00 AM **Short Presentations: REU Ethics Component** (Jeff Evanseck, Duquesne University)

Robert Skipper, Chair and Professor, Department of Philosophy, St. Mary’s University, San Antonio

“Exploring Ethics for Undergraduates”

Gloria Thomas Magee, Assistant Professor, Department of Chemistry, Xavier University of Louisiana

“A Chemist’s Start in Ethics and Engaging Undergraduates”

9:00 – 9:15 AM **Instructions for Breakout Session III** (Jeff Evanseck, Duquesne University)

9:15 – 10:15 AM **Breakout Session III: Development of an Action Plan and the Role of the Leadership Group. Transformative Ideas for the Future.**

10:15 – 10:45 AM **Coffee Break and Completion of Workshop Survey**

10:45 -11:45 AM **Breakout Session III Reports** (Moderator: Jeff Evanseck, Duquesne University)

11:45 AM **Workshop wrap-up** (Cindy Larive, University of California - Riverside)

12:00 PM **Adjourn**

Appendix D

About our speakers:

Mary Boyd, University of San Diego mboyd@sandiego.edu

Mary K. Boyd is Dean of the College of Arts and Sciences and Professor of Chemistry at the University of San Diego. Prior to coming to USD she was Professor and Chair of Chemistry at Georgia Southern University and a faculty member in the Department of Chemistry at Loyola University Chicago. Dr. Boyd was PI for REU programs at Georgia Southern and Loyola which emphasized the participation of students from underrepresented racial and ethnic groups. She established collaborations with regional LSAMP programs to recruit student participants. Dr. Boyd is co-editor of the new Council on Undergraduate Research publication "*Broadening Participation in Undergraduate Research: Fostering Excellence and Enhancing the Impact*", which shares strategies, principles and examples for building sustainable and successful programs. Dr. Boyd is a chemistry councilor for the Council of Undergraduate Research, and serves on the American Chemical Society Committee on Minority Affairs and the Executive Committee of the Division of Organic Chemistry. She has served as Secretary and Advisory Board member of the Inter-American Photochemical Society. Dr. Boyd is a past-Chair of the REU Chemistry Leadership Group.

"Broadening Participation in Undergraduate Research: Building Successful and Sustainable Partnerships to Provide Opportunities for Students from Underrepresented Groups"

Institutions that seek to provide undergraduate research opportunities to students from underrepresented groups may find it useful to establish partnerships with institutions that have a large student population of these groups. These partnerships must be based on mutual respect, a true willingness to collaborate and be designed to serve the needs of the students and benefit both institutions. This presentation will describe experiences partnering with faculty and administrators at LSAMP institutions to recruit students from underrepresented groups into REU programs.

Michelle Claville, Southern University and A&M College michelle_claville@subr.edu

Dr. Michelle Claville is currently Associate Professor and Chair of the Department of Chemistry at Southern University and A&M College, Baton Rouge, Louisiana. She attended the University of Florida, Gainesville, Florida where she received a B.S. in Chemistry from in 1993, and a Ph.D. in Organic Chemistry in 1998. As a graduate student, her research advisor was Professor William Dolbier, Jr. from who she inherited a passion for physical organic chemistry. After three and a half years as a Senior Research and Development Chemistry at Albemarle Corporation, she joined the faculty at SUBR in 2002. From 2003 to present, Michelle has supervised at least twelve undergraduate student researchers resulting in over 20 presentations at local, regional and national meetings. Michelle's research interests are mainly focused on the reactivity of certain radical species. More specifically, she is interested in the (1) reactivity of singlet oxygen on furan-containing pharmaceuticals, and (2) the resulting reactivity of distonic species that are generated from methionine-containing peptides which have either been subjected to single electron oxidation, or gamma irradiation. The latter of the two interests has recently earned Michelle an NSF CAREER Award entitled "CAREER: Generation and Fate of Distonic Radicals derived from Methionine-containing Peptides." Michelle is affiliated with the American Chemical Society (ACS), the National Organization for the Professional Advancement of Black Chemists and Chemical Engineers (NOBCChE), and Iota Sigma Pi Honor Society for Women in Chemistry. As dedicated as she is to her academic endeavors, Michelle's first love continues to be her husband, Eric, and sons, Ian and Ethan.

“Implementing and Building a Successful REU Program from a HBCU/MSI Perspective”

The Research Experiences for Undergraduate program is one of the most, if not the most, successful program for recruiting undergraduate students to, and engaging them in, scientific research. While a large number of universities across the country have successfully implemented REUs or REU-like programs, more still needs to be done to attract and retain under-represented minorities to the sciences. This seminar will offer suggestions to increase participation of under-represented students in research programs. It will also examine ways to bridge relationships between majority and minority-serving institutions, explore some attributes of some successful local and national REU-type programs, and expose some pitfalls that should be avoided.

Wilfredo Colon, National Science Foundation wcolon@nsf.gov

Sandra Laursen, University of Colorado at Boulder Sandra.Laursen@Colorado.EDU

Sandra Laursen is co-director of Ethnography & Evaluation Research, an independent research unit at the University of Colorado at Boulder. E&ER's interdisciplinary team conducts research and evaluation studies of education and career paths in science, engineering, and mathematics. Recent projects have examined the advancement of academic women scientists, programs to enhance the success of minority science students, outreach programs in biology and geology, and a multi-campus initiative to improve undergraduate mathematics education. A new study is investigating graduate education and career preparation in chemistry, and a forthcoming book discusses the outcomes of undergraduate research apprenticeships in the sciences. In addition to her research and evaluation work, Laursen is an outreach scientist at the Cooperative Institute for Research in Environmental Sciences, where she leads courses and workshops on Earth and physical science and inquiry-based teaching methods for K-12 teachers, college instructors, and scientists involved in outreach. She has a Ph.D. in physical chemistry, with research experience in photochemistry, free radical reactions, and atmospheric chemical kinetics.

“URSSA: A research-grounded tool for assessing student outcomes of REU programs”

URSSA, the Undergraduate Research Student Self-Assessment, is a new online tool for assessing student outcomes of undergraduate research in the sciences. In this brief introduction to URSSA, I'll describe its features and how it was developed, share information about how to access URSSA and customize it for your own program, and suggest some ways that individual programs and the REU community as a whole can make use of URSSA.

Cecile Brookover, Xavier University cbrookov@xula.edu

B. Cecile Brookover is an Assistant Professor in the Department of Psychology at Xavier University of Louisiana. She received her Ph.D. in Developmental Psychology with a minor in Program Evaluation and Statistics and also has an MBA. Dr. Brookover is a member of the American Evaluation Association and performs evaluations at Xavier for the NIH MARC and RISE Programs and for two state Board of Regents grants for the Biology and Math Departments.

“Intro to Program Evaluation Assessment: New or Existing Measures?”

Evaluation of the performance of educational programs requires the use of existing measures, when possible, and the construction of new tests. This presentation will focus on choosing

measures from available resources and constructing new assessments. Reliability, validity, and item analysis will be introduced, and a test construction exercise will be conducted.

Robert Skipper, St. Mary's University robert@skipperweb.org

Robert Boyd Skipper is chair of the philosophy department at St. Mary's University, in San Antonio, Texas, where he has taught since 1998. He received his B.A. in philosophy from St. Thomas University, in Houston, and received his M.A. and Ph.D. in philosophy from Rice. He has published articles in several scholarly philosophy journals, including *Ethics*, *The Journal of Business Ethics*, *The International Journal of Applied Philosophy*, *Philosophy and the Contemporary World*, and *Teaching Philosophy*, but also in various business journals, including *The Journal of Marketing* and *Business Horizons*. He has been the director of the Texas Regional Ethics Bowl since 2001 and has been a case-writer for the National Ethics Bowl since 2007. The ethics courses he has taught at St. Mary's have covered topics such as Foundations of Ethics, Engineering Ethics, Professional Ethics, Moral Theories, and Ethics in the Computer Age. He has also given several continuing education seminars on ethics for Professional Engineers.

Ethics is more than following a set of rules or a code of behavior. It is a way of thinking about or reflecting on one's actions. This type of reflection has been missing from the traditional science classroom, but this need not be the case. In this talk, I will offer several suggestions about how to introduce ethical thinking into to an undergraduate research project. In particular, I will show how students might keep an ethics notebook in which they record their reflections about the ethical issues they encounter at all phases of their research, from its initial conception, through its publication. I will show how the PI can focus the student's observations and reflections on a cluster of ethically relevant topics, and how the PI can guide the student as they explore these topics. To assist in this guidance, I will offer a handful of questions that are most likely to generate insights into the ethical issues that are present in the student's research. Then, I will demonstrate how the process works by applying the questions to a few published case studies and showing how quickly the questions get to the heart of the ethical issues. Time permitting, I will take a case containing no apparent ethical issue, and show how the questions would generate ethical insights into it, as well. Finally, I will suggest ways to objectively assess the student's ethics notebooks and mention some important resources for further exploration.

**Appendix E Breakout Session I: Challenges of Broadening Participation
(Thurs, 9:15 – 10:30 am)**

1. What are the best predictors for successful outcomes (in terms of research productivity, retention of students in science, matriculation into graduate programs, etc.) when recruiting/ selecting participants for REU programs? **Moderator: Tim Hanks, Furman University**

Bradley Miller, American Chemical Society
Scott Nickolaisen, Cal State LA
Karl Haushalter, Harvey Mudd
Tom Krugh, U. Rochester

Amy Prieto, Colorado State University
David Collard, Ga Tech
Hongtao Yu, Jackson State
Kenneth Brown, Hope College

2. What have been the most effective strategies for broadening participation at your REU site?

Moderator: Jenny Brodbelt, University of Texas at Austin

Daniel Downey, James Madison
David Spivak, Louisiana State
Elon Ison, NC State
Brian Frost, U. Nevada, Reno

Arne Gericke, Kent State
Jonathan Parquette, Ohio State
Michael Pullin, New Mexico Inst of Mining Tech

3. What are the impacts and payoffs of involvement of freshmen/sophomores and community college students in REU programs? **Moderator: Sarah Larsen, Univ. Iowa**

John Dighton, Rutgers Camden-Pinelands
Karin Ruhlandt-Senge, Syracuse U
Ben Jang, Texas A&M Commerce
Susan Lever, U. Missouri

Daniel Dyer, Southern Illinois at Carbondale
Holly Gaede, Texas A&M University
David Paul, U. Arkansas

4. What are the most effective strategies for building sustainable bridges between non-HBCU/MSI and HBCU/MSI programs?

Moderator: Gloria Thomas Magee, Xavier University of Louisiana

Katrina Miranda, U. Arizona
Robin Garrell, UCLA
Bruce Ault, U. Cincinnati
Jeanne Basom, U. Oregon

Fillmore Freeman, U. California at Irvine
Rebecca Braslau, UC Santa Cruz
Christian Brueckner, U. Connecticut

5. How can REU practices be translated into broadening participation along the pipeline (graduate education, academic careers)? **Moderator: Cindy Larive, UCR**

Aravind Asthagiri, U. Florida
Sankaran Thayumanavan, U. Mass, Amherst
James Penner-Hahn, U. Michigan, Ann Arbor
Julio Turrens, U. Southern Alabama

Joseph Heppert, U. Kansas Center for Research
Abby Parrill, U. Memphis
Garon Smith, U. Montana

6. What are the best practices for insuring research productivity in REU programs?

Moderator: Jeff Evanseck, Duquesne University

Banita Brown, U. North Carolina, Charlotte
Rob Petros, U. North Texas
Robert Bateman, U. Southern Mississippi
David Haines, Wellesley College

Evguenii Kozliak, U. North Dakota
Peter Qin, U. Southern California
Peter Armentrout, U. Utah

7. What are the most significant hurdles faced when broadening participation in REU programs? **Moderator: Eugene Billiot, Texas A&M Corpus Christi**

Denise Bale, U. Washington
Lisa Dorn, U. Wisconsin-Oshkosh
Gary Sulikowski, Vanderbilt U.
James Brozik, Washington State University

Alan Gengenbach, U. Wisconsin-Eau Claire
John Hoberg, U. Wyoming
Maggie Bobbitt Bump, Virginia Tech

Breakout Session II: Evaluation Tools and Strategies (Thurs, 2:15 – 3:30 pm)

1. What are the pro's and con's of a Common Evaluation Tool?

Moderator: Eugene Billiot, Texas A&M Corpus Christi

Denise Bale, U. Washington

Charlotte Aravind Asthagiri, U. Florida

John Dighton, Rutgers Camden-Pinelands

Hongtao Yu, Jackson State

Banita Brown, U. North Carolina,

Katrina Miranda, U. Arizona

Daniel Downey, James Madison

2. If a Common Evaluation Tool were to be adopted, what should it assess?

Moderator: Gloria Thomas Magee, Xavier University of Louisiana

Alan Gengenbach, U. Wisconsin-Eau Claire

Robin Garrell, UCLA

Karin Ruhlandt-Senge, Syracuse U

Kenneth Brown, Hope College

Evguenii Kozliak, U. North Dakota

Joseph Heppert, U. Kansas Center for Research

Arne Gericke, Kent State

Tom Krugh, U. Rochester

3. What assessment data do Site Directors need?

Moderator: Cindy Larive, University of California at Riverside

Lisa Dorn, U. Wisconsin-Oshkosh

Sankaran Thayumanavan, U. Mass, Amherst

Susan Lever, U. Missouri

Karl Haushalter, Harvey Mudd

Peter Qin, U. Southern California

Fillmore Freeman, U. California at Irvine

David Spivak, Louisiana State

4. What assessment data would most convincingly justify the value of the REU program to policy makers or the public?

Moderator: Jeff Evanseck, Duquesne University

John Hoberg, U. Wyoming

Abby Parrill, U. Memphis

Daniel Dyer, Southern Illinois at Carbondale

David Collard, Ga Tech

Rob Petros, U. North Texas

Rebecca Braslau, UC Santa Cruz

Jonathan Parquette, Ohio State

5. What student demographics are most impacted by a research experience? How do we know?

Moderator: Sarah Larsen, University of Iowa

Maggie Bobbitt Bump, Virginia Tech

James Penner-Hahn, U. Michigan, Ann Arbor

David Paul, U. Arkansas

Scott Nickolaisen, Cal State LA

Elon Ison, NC State

Bruce Ault, U. Cincinnati

Michael Pullin, New Mexico Inst of Mining Tech

6. Is a REU experience a cost effective way for students to gain research experience? Are there alternative models?

Moderator: Jenny Brodbelt, University of Texas at Austin

Gary Sulikowski, Vanderbilt U.

Garon Smith, U. Montana

Peter Armentrout, U. Utah

Amy Prieto, Colorado State University

Robert Bateman, U. Southern Mississippi

Christian Brueckner, U. Connecticut

Holly Gaede, Texas A&M University

7. How can we get a global view of the impact of the REU Program?

Moderator: Tim Hanks, Furman University

James Brozik, Washington State University

Julio Turrens, U. Southern Alabama

Ben Jang, Texas A&M Commerce

Bradley Miller, American Chemical Society

David Haines, Wellesley College

Jeanne Basom, U. Oregon

Brian Frost, U. Nevada, Reno

Breakout Session III: Development of an Action Plan and the Role of the Leadership Group. Transformative Ideas for the Future. (Friday, 9:15 to 10:15 AM)

1) Define the role/mandate of the Leadership Group. Should the Leadership Group be an influencer, mediator, or enabler of the REU Chemistry community?

Moderator: Jeff Evanseck, Duquesne University

Bradley Miller, American Chemical Society

David Spivak, Louisiana State

David Paul, U. Arkansas

Julio Turrens, U. Southern Alabama

Peter Armentrout, U. Utah

Lisa Dorn, U. Wisconsin-Oshkosh

Rebecca Braslau, UC Santa Cruz

Evguenii Kozliak, U. North Dakota

2) Evaluate the effectiveness and utility of the Leadership Group website. What additional tools/information should it offer? Would Facebook/listserv or discussion board be beneficial?

Moderator: Gloria Thomas Magee, Xavier University of Louisiana

Amy Prieto, Colorado State University

Michael Pullin, New Mexico Inst of Mining Tech

Holly Gaede, Texas A&M University

Kenneth Brown, Hope College

David Haines, Wellesley College

John Hoberg, U. Wyoming

Christian Brueckner, U. Connecticut

3) How should REU sites utilize current technologies to be more effective?

Moderator: Eugene Billiot, Texas A&M Corpus Christi

Scott Nickolaisen, Cal State LA

Brian Frost, U. Nevada, Reno

Jeanne Basom, U. Oregon

Daniel Downey, James Madison

Alan Gengenbach, U. Wisconsin-Eau Claire

Gary Sulikowski, Vanderbilt U.

Garon Smith, U. Montana

4) Define ideal REU sites of the future. Think out-of-the-box without limitations or constraints.

Moderator: Tim Hanks, Furman University

Hongtao Yu, Jackson State

Daniel Dyer, Southern Illinois at Carbondale

Karin Ruhlandt-Senge, Syracuse U

Abby Parrill, U. Memphis

Robert Bateman, U. Southern Mississippi

James Brozik, Washington State University

Aravind Asthagiri, U. Florida

5) Develop a five year action plan for the NSF REU Program.

Moderator: Cindy Larive, University of California at Riverside

Karl Haushalter, Harvey Mudd

Jonathan Parquette, Ohio State

Susan Lever, U. Missouri

John Dighton, Rutgers Camden-Pinelands

Peter Qin, U. Southern California

Denise Bale, U. Washington

Katrina Miranda, U. Arizona

6) What tools, programs, and opportunities should the Leadership Group offer to support and enhance the REU community? (travel grants, seminars, ethics, advertising, annual workshops on various topics....)

Moderator: Jenny Brodbelt, Univ.f Texas at Austin

Maggie Bobbitt Bump, Virginia Tech

Elon Ison, NC State

Sankaran Thayumanavan, U. Mass, Amherst

Joseph Heppert, U. Kansas Center for Research

David Collard, Ga Tech

Bruce Ault, U. Cincinnati

Banita Brown, U. North Carolina, Charlotte

7) What are the most critical issues facing REU programs that need to be voiced?

Moderator: Sarah Larsen, University of Iowa

Ben Jang, Texas A&M Commerce

Tom Krugh, U. Rochester

Arne Gericke, Kent State

Robin Garrell, UCLA

Fillmore Freeman, U. California at Irvine

Rob Petros, U. North Texas

James Penner-Hahn, U. Michigan, Ann Arbor

Appendix F**Chemistry REU Pls Meeting Poster Session
July 8, 2009
San Antonio, TX**

Presenter	Title
Peter Armentrout	Chemistry Undergraduate Research at the University of Utah
Aravind Asthagiri	REU on Computational Materials Science
Bruce Ault	Research Experiences for Undergraduates in Chemistry at the University of Cincinnati: the Visiting Faculty Mentor Concept
Denise Bale	Hooked on Photonics: A Multi-Campus Research Experience for Undergraduates Program
Jeanne Basom	Research Experience for Undergraduates in Chemistry and Physics at the University of Oregon
Robert Bateman	Developing Undergraduate Researchers in Chemistry and Biochemistry
Maggie Bobbitt Bump	Design and Delivery of Polymer-Drug Complexes, A Team Approach for Building Leadership and Communication Skills
Rebecca Braslau	ThaiREU: Organic Chemistry in Bangkok, Thailand
Jenny Brodbelt	REU Site at UT-Austin: The Craft of Creativity
Banita Brown	Nanoscale Science Undergraduate Research Experiences (NanoSURE) at UNC Charlotte
Kenneth Brown	Professional Excellence and Development Through Undergraduate Research
Christian Brückner	REU in Chemistry at the University of Connecticut
James Brozik	WSU REU: Chemical and Physical Characterization of Biological Systems
David Collard	Research Experiences for Undergraduates in Chemistry and Biochemistry at the Georgia Institute of Technology
John Dighton	New Jersey Pinelands Research Experience for Undergraduates: Rutgers Camden – Pinelands

Presenter	Title
Lisa Dorn	University of Wisconsin Oshkosh Research Experience for Undergraduates in Proteomics and Functional Genomics
Daniel Downey	Undergraduate Research at JMU in Chemistry and Biochemistry: An REU Site that Includes Deaf Participants
Daniel Dyer	REU Site on Interdisciplinary Materials Research at SIUC
Brian Frost	REU Site: Research Experience for Undergraduates in Chemistry at the University of Nevada
Jeffrey D. Evanseck	Integrated Computational and Experimental Research Experiences
Jeffrey D. Evanseck	The Chemistry Leadership Group 2009
Holly Gaede	Biological, Environmental, and Materials Research at Texas A&M University
Robin Garrell	NanoCER: Nanosystems Chemistry and Engineering Research, an REU Site at UCLA
Alan Gegenbach	NSF-REU: Collaborative Undergraduate Research Experiences in Chemistry (CURE CHEM) at UWEC
David Haines	REU Site: Chemistry as the Focus of an Interdisciplinary Summer Research Program at Wellesley College
Tim Hanks	REU at Furman: Faculty/Student Teams Investigating the Grand Challenges of Chemistry
Karl Haushalter	Chemistry Research Experiences for Undergraduates at Harvey Mudd College
Joseph Heppert	A Summer NSF-REU Program Integrating Research, Education, and Career Development in an Interdisciplinary Environment (University of Kansas site)
Elon Ison	Research Experiences for Undergraduates (REU) Program at the Department of Chemistry at NC State University
Ben W.-L. Jang	Research Experience for 2-year College Undergraduates in Chemistry at Texas A&M University-Commerce
Evguenii Kozliak	The Sustainable Energy Research Experience for Undergraduates in the Chemical Sciences

Presenter	Title
Thomas Krugh	Research Experience for Undergraduates at the University of Rochester
Sarah Larsen	Undergraduate Research Opportunities in Nanoscience and Nanotechnology
Susan Lever	An introduction to Radiochemistry Research at the University of Missouri – Columbia
Katrina Miranda	Collaborative Research in the Chemical Sciences at the University of Arizona
Scott Nickolaisen	Research Experience for Undergraduates in Chemistry and Biochemistry at CSULA
Jonathan Parquette	Interdisciplinary Research for Undergraduates at OSU
David Paul	University of Arkansas REU Site Project: Directing Students to Scientific Careers
James Penner-Hahn	University of Michigan REU Site in the Chemical Sciences
Robby Petros	REU Site: Opportunities in Chemistry at the University of North Texas
Amy Prieto	NSF-REU at Colorado State University
Michael Pullin and Lisa Majkowski	Interdisciplinary Science for the Environment: A Summer REU Program at New Mexico Tech
Peter Qin	Snapshots of Chemistry: REU at University of Southern California
Karin Ruhlandt-Senge	REU Site at Syracuse University - Undergraduate Research in Chemistry - IREU Site International Experience for Chemistry Undergraduates in Austria
Garon Smith	An Environmental Chemistry REU with Environmental Policy and Scientific Ethics
David Spivak	Integration of Science and Culture at LSU
Sankaran Thayumanava	Collaborative Undergraduate Research in Energy Program: UMass Amherst
Julio Turrens	Structure and Function of Proteins
Hongtao Yu	Research Experience for Underrepresented Minorities in Nanoscience and Nanotechnology