AC 2008-2491: OUTCOMES OF A NOVEL REU SITE IN CHEMISTRY & CHEMICAL ENGINEERING

Adrienne Minerick, Mississippi State University

Outcomes of a Novel REU Site in Chemistry & Chemical Engineering

Adrienne R. Minerick

Dave C. Swalm School of Chemical Engineering
Mississippi State University
Mississippi State, MS 39672

Abstract – National Science Foundation, Research Experiences for Undergraduates (REU) programs have become widely regarding as a beneficial experience for undergraduate students considering graduate school. Successful sites offer professional development opportunities for the REU participants on many levels. These levels include (but are not limited to) the research project itself, soft and technical skills development, and participant camaraderie. This work will act as a retrospective after the first three years co-directing a collaborative REU site at Mississippi State University entitled, "Chemistry – Chemical Engineering: The Bonds Between Us." This Bonds REU site combined the research strengths of the chemistry and chemical engineering disciplines in a synergistic relationship. Participants gained experience, techniques, and perspectives from both fields. The program was so successful that by year three, 20 students participated even though NSF funded only 9 on the grant. This retrospective focuses on measures of success for student development in the program; assessment figures are reported.

Keywords: Research Experience for Undergraduates, Research Program, Professional Development, Projects.

INTRODUCTION & BACKGROUND

The National Science Foundation (NSF) has an ongoing effort known as a Research Experiences for Undergraduates (REU) program [1]. The goal of this program is to support active research participation by undergraduate students with the long-term goal of encouraging more students to pursue advanced degrees and to increase participation of groups traditionally underrepresented in science and engineering. One key attribute of such a program is that the REU projects must involve students in meaningful ways – i.e. the undergraduates may not be simply lab technicians. It is viewed favorably if the REU Sites include professional development training including ethics. Also, involving participants from diverse schools across the country (especially those from primarily undergraduate institutions) as well as inclusion of an international component is also viewed as favorable because it broadens REU Participant perspectives and increases the breadth of their training. The research theme of REU Sites is open to any research area that NSF currently funds. Of course, themed sites with an interdisciplinary or multi-department research component are good.

Purpose and Goal of REU Programs

REU site programs may run during the school year, but the most common form is a summer internship. A ten-week summer experience that enables an undergraduate student to emerge himself or herself in research can be a life-changing experience. For the students, it really is a no-risk chance to see if they love research. The students are paid a stipend along with other support which may include housing, food, trips, and miscellaneous. Students are typically paired with a faculty advisor and possibly a graduate student mentor. These mentors help guide the undergraduate student through their first independent research experience. Exit evaluations and discussions with participants often indicate that they are surprised when their projects do not work perfectly in line with the objectives they were assigned at the beginning of the summer (unlike the "cookbook" undergraduate lab classes they may have previously experienced). A previous REU participant summarized this feeling in his / her exit evaluation as, "It's called re-search - things fail, and you are supposed to try again. Otherwise it would just be called search."

The purpose of REU programs is to provide a meaningful, hands-on experience that hopefully excites students into pursuing advanced degrees in their field.

Attributes & Outcomes of "The Bonds Between Us" Program

The Bonds Between Us Program strove to combine the research strengths of the chemistry and chemical engineering disciplines in a synergistic relationship [2]. Participants gained experience, techniques, and perspectives in the chemical sciences that illustrated how chemists and chemical engineers approach similar research challenges from different perspectives. Research themes featured were Biotechnology & Bioanalytical Applications, Nanomaterials & Structural Studies, Integrated Environmental Research, and Synthesis & Separation Processes. Participants benefited from close mentoring relationships with graduate students and faculty. Professional development and research skills training was interspersed with laboratory research, site visits of chemical plants and national research labs, social activities, interactive workshops in diversity and research ethics, and an end-summer symposium. At the conclusion of the summer, they presented at a campus-wide symposium with the option of submitting an abstract to present at regional meetings, such as those of the American Chemical Society (ACS) and the American Institute of Chemical Engineers (AIChE).

The program was designed with the following attributes and outcomes in mind:

- State-of-the-art research experiences that motivate students to pursue graduate degrees in chemistry, chemical engineering, or related field.
    - Broad participation of students from underrepresented groups in chemistry & chemical engineering
    - Increased appreciation and understanding of complementary discipline
- Sense of community among REU students, faculty, and graduate student mentors
- Strengthened/increased collaboration between chemistry and chemical engineering disciplines
- Enhanced educational and mentoring experience for graduate students

A total of 45 undergraduates (27 NSF funded positions) participated in The Bonds REU from 2005 to 2007. Of this total, 20 ethnic minorities (13 African-Americans, 7 Hispanics, and 1 Pacific Islander) and 21 women participated. In this paper, evaluation results for the 2007 program (20 participants) are reported. Comparisons of student perceptions of research both before and after the research experience are discussed. The actual research experience itself was assessed as well as the professional development workshops and activities. Finally, the overall organization of the program was evaluated in order to build upon shortcomings and improve the program. Overall conclusions regarding "Chemistry / Chemical Engineering: The Bonds Between Us" summer research program which ran during the summers of 2005, 2006, and 2007 are included.

ASSESSMENT OF THE 10-WEEK RESEARCH PROGRAM

Participants filled out surveys at the beginning of the program, after major workshops or professional development events, and at the end of the 10-week program. The surveys were all conducted anonymously via webCT. Each survey was linked so that we could track individual impressions throughout the program. This was accomplished by having the participants draw the name of a cartoon character out of a hat. They would enter this characters name at the top of each survey so that the surveys could be linked throughout the summer. The students were asked to respond to statements on a 5-point Likert scale that ranged from Strongly Agree to Strongly Disagree with Neutral in the middle. Questions were asked in five main categories, which included: Impressions of Research, Professional Development, Evaluation of Mentors, Participant Dynamics, and Programmatic Evaluation. The full survey is provided in Appendix A.

All surveys were approved by the Institutional Review Board for the Protection of Human Subjects. Further, students were given consent forms and well informed that they did not need to participant as a requirement of the program. All students chose to participate so figures for 2007 included 20 participants.

Preliminary vs. Final Perceptions of Research

Comparisons were made between student perceptions of research the day they arrived on campus to the day before they left campus at the completion of their ten-week research experiences for undergraduates program. This section included eight Likert scale questions on impressions and one essay question where students could offer qualitative comments. The initial survey also included a question asking if the student had extensive research experience prior to this program as shown in Figure 1. The statements the students responded to were (also included in the Appendix) with 5 = strongly agree and 1 = strongly disagree:

1) Both chemistry and chemical engineering are equally important to chemical research.
2) I have a fair understanding of what the other discipline involves.
3) I prefer collaborative / team environments.
4) I enjoy laboratory research.
5) I am comfortable performing independent research in the laboratory.
6) I intend to pursue a graduate degree (Masters or Doctorate).
7) I value working with people from different cultures and backgrounds.
8) I am self-motivated.
9) I have had extensive research experience prior to this program.

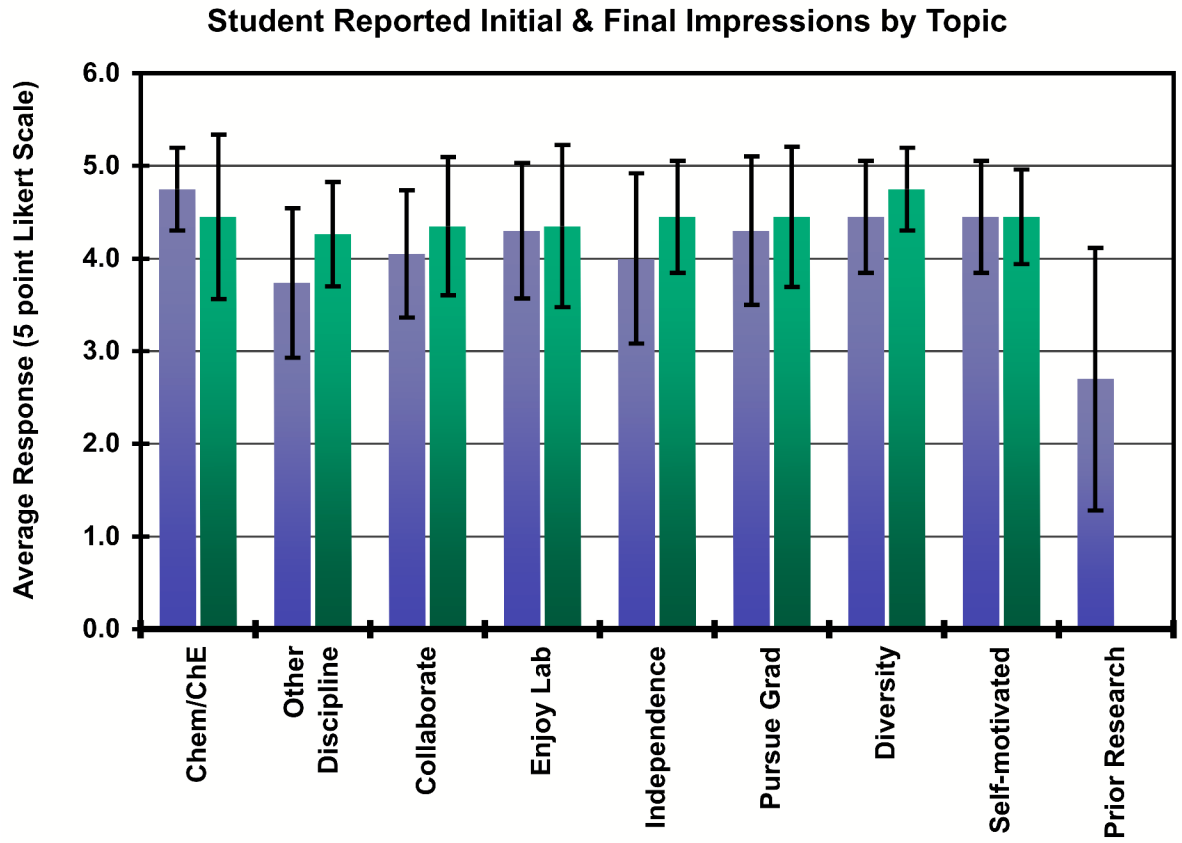

Figure 1: Comparison of initial and final participant impressions of complimentary discipline, research attributes and diversity

Eight of the 9 data points shown in Figure 1 are impressions while the last question was simply a gauge on how many students had participated in research prior to this REU program. As shown by the median average and large standard deviation, the entering skill level of participants varied from none at all to significant involvement in research. As can be further noted from Figure 1, the responses are slightly higher in the final evaluations with smaller standard deviations. Some key exceptions to this generality are with regards to the question of both chemistry and chemical engineering being equally important to chemical research. It is unclear if this dropped because the program did not succeed in adequately demonstrating how the other discipline approaches a similar

research problem. However, when students were asked if they had an understanding of the complimentary discipline, their responses were much higher after the program than before (3.74 to 4.26). The questions on enjoying collaborative / team environments and working with people from diverse backgrounds showed the student's strongly agreed with this philosophy (4.35 and 4.75, respectively), an area of definite success for The Bonds program. There was a slight increase in the average of the students who said they strongly intended to pursue graduate degrees in chemistry or chemical engineering, another point of success for the program.

Assessment of Professional Development Activities

In addition to the research experience within the laboratory, the participants also received guidance on professional development including formal instruction and mentoring of research skills, hands-on observation of chemistry and chemical engineering in industry as well as at a national research laboratory, and interactive workshops on diversity, ethics, and a panel on attending graduate school.

Advanced Research Skills Course

The program has been scheduled to coincide with the 10 week summer term at Mississippi State University. As an unique and beneficial perk of the program, REU Participants enrolled in a three credit hour course, CH 4613 Advanced Research Skills, which they could transfer to back to their home institution. Topics covered in this course included: Safety, Research and the laboratory, How to maintain a lab notebook; Literature searches and article applicability to your research; Dissection of a research article; Effective scientific presentations; Preparing an abstract of your research project, and Preparing a scientific poster. At approximately week 6 of the program, all participants were mentored through preparing a 10–12 minute oral PowerPoint presentation of their research. Two afternoons were dedicated to participant presentations for the entire Bonds community (faculty, graduate students, and peers). For the final week of the program, students prepared a 3X4 foot poster on their finished research project. This was presented during the Closing Poster Symposia and the entire Bonds research community and the greater MSU community was invited.

Three questions were asked in the final survey that provided insight into the advanced research skills course. The statements were "I developed professionally as a result of the REU Bonds Experience." This statement yielded an average response on the Likert scale of 4.6 ± 0.75 while the statement "I am well informed about research environments and career options," earned a 4.15 ± 0.81 indicating that the participants overwhelmingly agreed that this program had a positive impact on their professional skills and perceptions. To further explore the role of the course, the participants were asked, "How satisfied have you been with how the class interfaced with your research experience?" which yielded an average response of 3.55 ± 1.10. This number is slightly lower with a large standard deviation indicating that opinions were quite diverse regarding the course attributes. This has been targeted as an area for improvement in future REU sites.

Trips to a Local Chemical Plant and to a National Research Facility

In order to add depth to the participants understanding of the impact of chemistry and chemical engineering research within the larger world, on-site visits to a local chemical plant and to a national research laboratory were conducted. Eka Chemicals, Inc. in Columbus, MS sponsored visits for students to learn process chemistry and large-scale equipment function for a sodium chlorate and hydrogen peroxide production facility [5]. The second trip was to the US Army Corps of Engineers' Engineer Research and Development Center (a.k.a. Waterways Experiment Station) in Vicksburg, MS [6]. The tour of ERDC provided a diverse view of the many different areas of research including how numerous disciplines cooperated so closely in research that was directly applicable to current disasters (Katrina) or ecosystem needs (chemically controlling invasive species). During these tours, chemical processing, research, development and analytical facilities were featured. These experiences provided the students an appreciation for the applications of research.

The evaluation questions were modified slightly by adding the starred question below after the first plant trip to Eka Chemicals. The statements that the respondents were asked to agree or disagree with on a Likert scale were:

1. I feel this plant trip enhanced the REU Bonds experience
2. The plant engineer / tour guide was knowledgeable
3. I found it easy to ask questions.
*4. This activity provided valuable insights that I will use later.

4. What did you like most about the plant trips?
5. What did you like least about the plant trips?
6. What would you recommend to improve the plant trips?

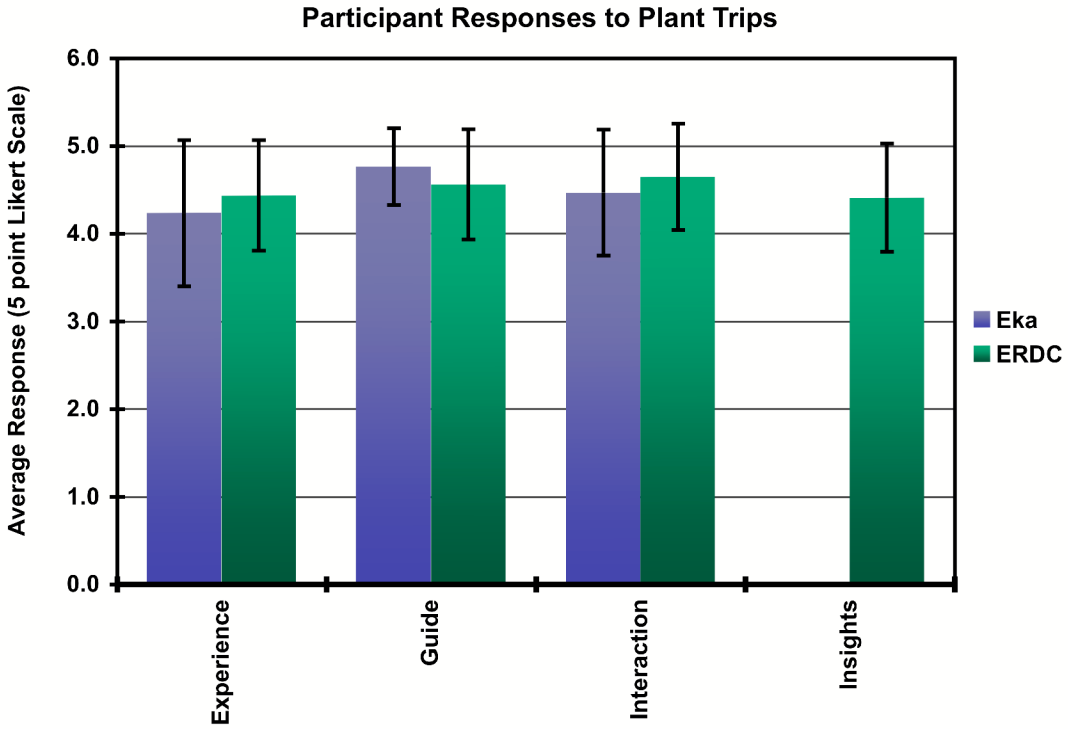

Figure 2: Participant Assessments of trips to Eka Chemicals and the US Army Corps of Engineers Engineering Research and Development Center (ERDC)

Student feedback on the additional plant trips to Eka Chemicals and the ERDC indicated that the student's viewed these activities as beneficial experiences. All responses were over 4 with the ERDC experience rated slightly higher in most cases than for Eka Chemicals. The response to 'the plant engineer / tour guide was knowledgeable' statement is slightly lower with a larger standard deviation for the ERDC and this is likely because the students met a new guide every 30 minutes because they were moved from lab to lab. This setting would likely not have given them as much time to ask questions of the engineers and scientists. Overall, this aspect of the program was a benefit for the participants.

Workshops on Diversity, Ethics, and Graduate School

Three 2 to 3-hour workshops were held during the summer program and were conducted in cooperation with the other REUs on campus. The first workshop was conducted by the REU PI and focused on diversity and included an interactive game encouraging thought regarding responses based on categorization of types of people. A Naval Reserve officer and recognized ethics trainer for the National Society of Professional Engineers helped conduct the Ethics Workshop. For the Graduate School workshop, the Dean of the Graduate School conducted the session, which focused on addressing student's questions about applying and successfully attaining an advanced degree. Current graduate students in chemistry, chemical engineering, and other applicable areas (for the coinciding REU programs) were also invited to attend and answer questions in a panel structure. Student assessments were conducted after each workshop in order to provide data for formative improvement of the workshops from year to year.

The evaluation questions asked after the workshops were as follows, again on a Likert scale:

1. How satisfied are you with the materials provided for this activity?

2. How satisfied are you with your opportunity for questions / input / interaction?
3. How satisfied are you with the quality of the speaker(s), instructor, staff, etc.?
4. This activity changed my initial perceptions.
5. This activity provided valuable information / skills that I will use later.
In addition, three essay type questions were asked and were:
6. What did you like most about this activity?
7. What did you like least about this activity?
8. What would you recommend to improve this activity?
The responses for each of the three workshops for the first 6 questions are included in Figure 3.

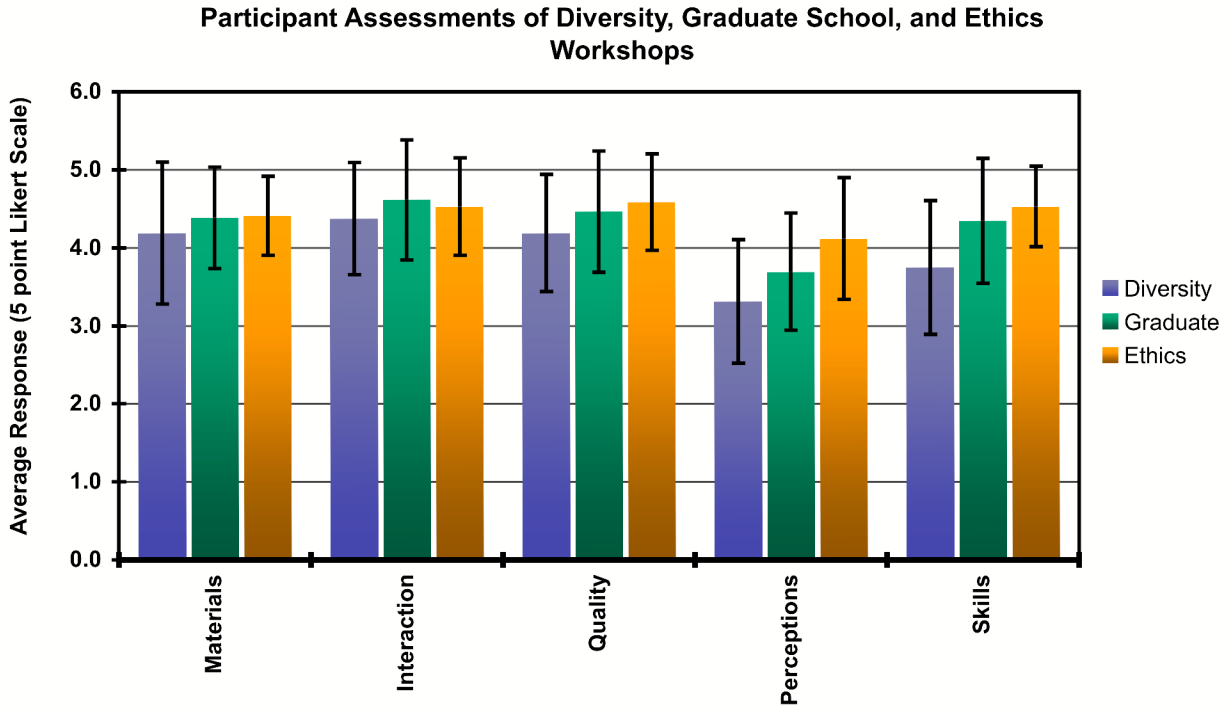

Figure 3: Participant Assessments of Professional Development Workshops

For the most part, the participants found the workshops to be beneficial. On all questions, the diversity workshop ranks lower than the other workshops. This was reinforced in the comments to the open ended questions. The students felt that the activities were geared toward too young of an audience. However, their responses indicate that the information was still useful – there is just room for improvements in this area. In almost all cases, the Ethics workshop was the most useful for the participants. In this workshop, the students ranked highly (4.53±0.51) the skills they attained. The graduate school workshop was also beneficial for the students. In the comments, they felt that the question and answer period with the graduate student panel was the most beneficial component of the workshop. In response to the question of whether the workshop changed their perceptions, the average responses to this are 3.31, 3.69, and 4.12. While these scores are much closer to a neutral rating on the Likert scale, this is not a cause for concern given that many students feel they are already fairly open and accepting of other cultures. This information will be used to develop activities for subsequent workshops.

The Mentorship Experience

Students value professional, yet enthusiastic interactions with their faculty and graduate student mentors. The primary goal of a summer research experience is to offer an informative, positive immersion in research so that participants can make an informed decision as to whether they would like to pursue an advanced degree in chemistry or chemical engineering or pursue a career in research. Therefore, it is necessary to have well-defined projects that enable successively more independence as the participant's competency grows. It is important that the project enable true research and that the participant does not simply act as a lab technician for a graduate student's project.

An ideal REU project has a solid foundation from the mentor's ongoing research efforts that is within the expertise of any graduate student mentors. The project should have a preliminary literature survey conducted and organized for the student such that the student can build upon this body of literature. Per NSFs requirements, the project needs to contain an independent problem solving component and this necessitates that the student have clear, attainable objectives with immediate access to necessary research tools. The scope should be sufficiently narrow such that controls and dependencies are apparent and thus yield meaningful outcomes.

Providing the student a project description along with descriptive objectives and estimates of the timeline for each objective is particularly useful. At the beginning of the summer, students think they have all the time in the world to complete the project, but by about week 6, they are frantically trying to finish up experiments. By providing smaller objectives and shorter milestones, inexperienced students do much better at managing their time. Structuring training as an apprentice progressing to a journeyman, objectives that include becoming proficient on a piece of equipment or preparing a sample with certain properties are useful.

Student assessments of research projects and mentors were conducted via one question during the initial evaluation (*) and a series of 7 questions (5 ranked, 2 essay) as part of the final evaluation. This data is particularly useful for formative improvement of the workshops from year to year.

1. How satisfied are you with the method of selecting a research mentor?
2. How satisfied are you with the overall quality of communication between you and your research mentors?
3. How satisfied are you with the amount of supervision provided by your research mentors during the program?
4. How satisfied are you with the research nature of the laboratory activities you were assigned (e.g., not menial labor)?
5. How satisfied are you with your interactions with other participants in the program?
6. How satisfied are you with your experience at Mississippi State University?

In addition, two essay questions were asked:

7. What do you like most about your mentors?
8. What do you like least about your mentors and what improvements would you recommend?

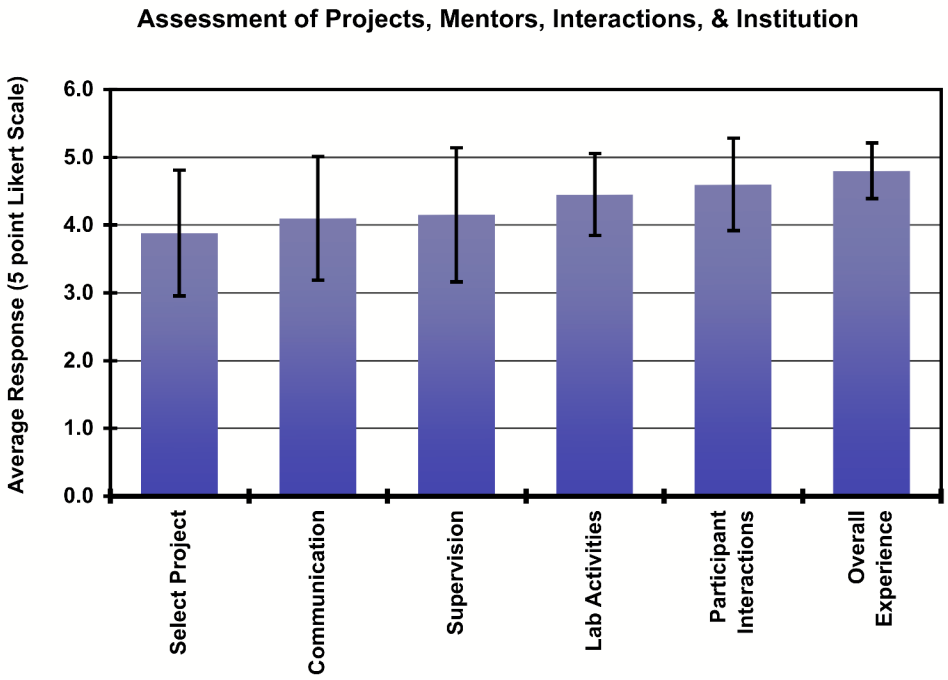

Figure 4: Participant assessment of project selection and their interactions with their mentors and other participants.

Students generally felt that the communication with and supervision by their mentors (faculty and graduate students) was good, although the average was such that there is room for improvement in this area. Supervision is a tricky

area anyway because most students need to feel out of their comfort zone sometimes in order to encourage them to transition to independent problem solving. The lab activities were viewed favorably (4.45) as were participant interactions with each other (4.6). The overall experience was very strongly rated with an average agreement with the statement, "How satisfied are you with your experience at Mississippi State University?" of 4.8.

The first question in Figure 4 was asked on the initial survey and asked if the participants liked how projects were selected. The result of this (3.88±0.91) is not where the organizers would like it. One thing is given; it is important that participants be allowed to select the project that most interests them. The challenge is how to accomplish this and two mechanisms have been tried in the past. One mechanism is to have the students rank project preference based on a short written abstract description before they arrive on campus. The second mechanism is to have the student tour each of the labs and meet mentors during their first two days on campus and then provide a ranking of their project preferences. There are pros and cons to each situation and as a result of the feedback in these evaluations, our site has propose a new novel selection mechanism. In the next summer program, participants will select projects by touring the labs, meeting mentors, and ranging their preferences. Then, the organizers will develop virtual tours and podcasts using the REU students and their projects as subject matter. These virtual tours will be added to the REU website for project selection in the subsequent summer and simultaneously used for public relations / advertising for the program. Participants will then be able to read project descriptions and simultaneously take the virtual tours to decide their project preferences. By selecting their projects before arriving, faculty can pre-order supplies and participants can begin reading background information before arriving on campus.

Participant Dynamics and the REU Climate

The tone of the program is determined early in the program. A climate that supports close participant camaraderie will do more for facilitating a positive experience for students than anything else. This climate is created by how the facilitators cast opening activities in the start of the program. Student groups that form a strong friendship early sustain this throughout the summer and are more likely to encourage each other through any challenges with their research project. Because the participants are also having fun, their capacity for learning is better and their enthusiasm builds throughout the summer. The student participants were assigned office space together in a central room between the two lab buildings. This helped facilitate communication beyond emails once the students began working on their independent projects. In 2007, the students developed their own group on Facebook and communicating activities through that venue proved to be very effective. The key lesson learned in this category is that one cannot communicate with the various individuals involved in such a program too frequently.

Planned Social Activities

For The Bonds program, a day was spent experiencing the surrounding community via a guided tour from the local Chamber of Commerce. While this was not mandatory, a majority of the participants moved into their dorm with enough time to go on this tour. The following day was the official start of the program and included a tour of campus and completion of all necessary paperwork for ID cards, dispersal of their first stipend check, and a Meet and Greet Bowling Social. The second day was a formal welcoming ceremony followed by lab tours, one-on-one visits with mentors and project selections. The participants then began their projects with their mentors and at the end of the first week were brought back together for a planned pool party social. In one week, it was amazing how close and tight friends they seemed. REU Participants also participated in the Big Dawg Adventure Challenge Course, a team building exercise run by MSU's Department of Recreational Sports. This team strategy and trust workshop consisting of physically and mentally challenging ropes course requires a combination of teamwork and individual commitment [7]. Additional planned social activities throughout the summer included a Fourth of July picnic, dinners after workshops, and an end of summer pool party.

Unplanned Social Activities

In past years, the participants have self-organized road trips to Memphis, New Orleans, or the Gulf Coast because local participants have wanted to show off their homes and national/international participants have been avid tourists of the southeast region. Also, by including graduate student mentors in first week social activities, the participants tied into the local social community very quickly. They had events planned nearly every day each weekend. Collectively, the social networking among REU participants was a very important component to the tone, enthusiasm and success of The Bonds program. No formal assessment of these components of the program was

conducted. However, the enthusiasm and bonding that occurred between the participants was interpreted as success in this area.

Overall Organization and Perceptions

Coordination of program schedule, research course, trips to industrial plant and national lab, welcoming and closing activities, social events, and other required careful communication and planning. Communication with the student participants was important prior to and during the program. Coordination with faculty and graduate student mentors, professional development workshops, and student development activities with the instructor of the research course were also important. Composite averages were calculated from the student assessments in five categories including:

1. Final impressions of research, the complimentary discipline, and other related skills. The original questions for this area are listed under "Preliminary vs. Final Perceptions of Research" and are numbers 7 through 15 in Appendix A.
2. Composite average of student assessment of mentoring. The questions that were included in this are listed under section "The Mentorship Experience" and are numbers 16-19 in Appendix A.
3. Composite participant assessment of their own professional development. Two questions were included in this composite average which were in the subsection "Advanced Research Skills Course" under section "Assessment of Professional Development Activities". These questions are numbers 3 and 4 in Appendix A
4. Overall assessment of workshops is a composite average of responses to all workshop questions listed in the subsection "Workshops on Diversity, Ethics, and Graduate School". These questions are also included in Appendix B.
5. Similarly, composite figures assessing the plant trips to Eka Chemicals and ERDC are provided. Original questions are listed in the subsection "Trips to a Local Chemical Plant and to a National Research Facility". These questions are included in Appendix C.

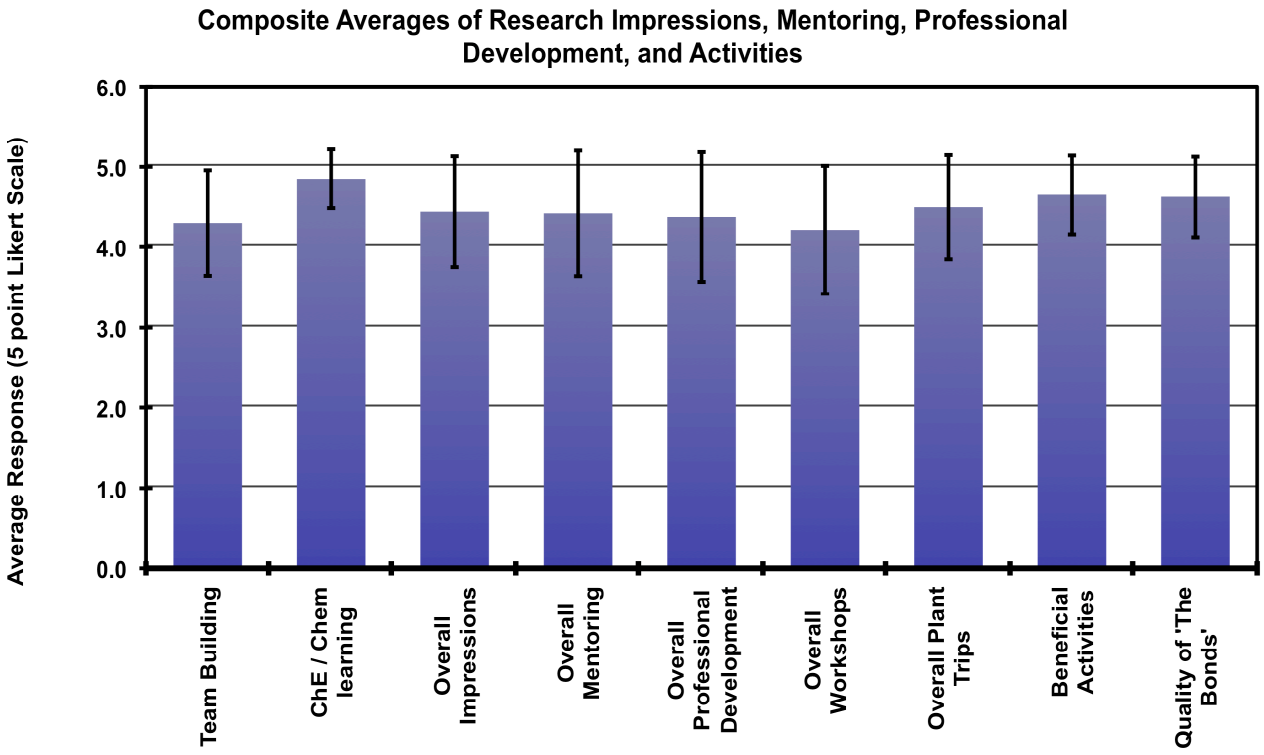

Figure 5: Composite figures to assess overall perceptions of The Bonds Program.

Further, four overarching questions are included in Figure 5 again rated on the 5 point Likert scale. These are:

6. How well do you agree with the following: The REU Bonds program promotes and facilitates teambuilding.
7. I enjoyed having the opportunity to learn from mentors in chemistry and chemical engineering.
8. The program activities were appropriate and beneficial.
9. Overall, the quality of The Bonds REU Program was:

Participant satisfaction in all categories is above 4 on a 5-point scale. This is superb and consistent with the program goals. The strong response to learning in chemistry and chemical engineering is particularly important as this addresses one of the primary goals of The Bonds theme, which was to combine the research strengths of the chemistry and chemical engineering disciplines in a synergistic relationship. The organizers couldn't have hoped for better scores in the beneficial activities and overall quality of 'The Bonds' program; with such small sample sets, even one student having a tepid experience can send this average down. There are areas that are noted to need improvements. The team building aspects of the program are perceived as slightly weaker and since this is an essential component to interdisciplinary research, it would be beneficial to focus more effort on developing skills and activities that promote such interactions. Next, the workshops can be improved by making them much more interactive with non-traditional, demonstrative activities. Responses indicate that the graduate school workshop ma have been too formal, so students were hesitant to ask their questions. Lastly, structured guidance to graduate students and faculty mentors and key interactions they can have with undergraduate researchers working on a project for an intensive 10 weeks would likely improve scores in this area. Overall, the scores indicate successful implementation of The Bonds program and suggest that the program was successful in providing a positive active research participation experience for undergraduate students which could potentially encouraging more students to pursue advanced degrees.

SUMMARY & CONCLUSIONS

This paper discussed the structure and assessment results of a National Science Foundation Research Experiences for Undergraduates site at Mississippi State University. The Bonds REU program goals were to support active research participation by undergraduate students with the long-term impact of encouraging more students to pursue advanced degrees and to increase participation of groups traditionally underrepresented in science and engineering. In the time that the "Chemistry / Chemical Engineering: The Bonds Between Us" program ran, 45 undergraduate participants (27 NSF funded) comprised of 20 ethnic minorities (13 African-Americans, 7 Hispanics, and 1 Pacific Islander) and 21 women participated. From the yearly assessments, much was learned about how to organize for a ten-week intensive research program, how to ensure each student had a meaningful, positive experience, how to promote camaraderie among participants, and how to streamline participant logistics. These lessons were summarized in this paper for 2007 results. Further, this contribution discussed the organizer's interpretation of the results and plans for improving the experience in subsequent years. Organized professional development activities were outlined in addition to a discussion of structured social activities to build trust, teamwork, and camaraderie. A ten-week summer experience can enable an undergraduate student to emerge himself or herself in research and can be a life-changing experience. Evaluation scores indicate that the program was successful in providing a positive active research participation experience for undergraduate students, thus potentially encouraging them to pursue advanced degrees.

ACKNOWLEDGMENTS

The author, REU Participants, and Faculty mentors gratefully acknowledge the contributions of The Bonds REU program's PI and co-director, Dr. Gloria Thomas. Without her hard work, active recruiting and mentoring of participants, as well as extensive programmatic efforts, this program would not have been possible. Special appreciation is extended to Dr. Alicia Beatty who taught the Advanced Research Skills course and who was one of the most active faculty mentors. Further, the workshop facilitators, administrative staff, and other people who contributed to this program are gratefully acknowledged.

REFERENCES

[1] National Science Foundation Research Experience for Undergraduates (REU) Program Solicitation http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5517&from=fund, Accessed 3 December, 2007.

[2] Chemistry: Chemical Engineering – The Bonds Between Us Website at Mississippi State University, http://www.msstate.edu/org/reubonds/index.php, Accessed 3 December, 2007.

[3] National Science Foundation, "Search for an REU Site," http://www.nsf.gov/crssprgm/reu/reu_search.cfm Accessed 3 December, 2007.

[4] Cutlip, Michael B., "Summary of Undergraduate Research Opportunities for Chemical Engineering Students During the Summer of 2007," http://www.engr.uconn.edu/~cutlipm/reu/ Accessed 3 December 2007.

[5] Azko Nobel: Eka Chemicals, Inc, plant in Columbus, MS http://www.eka.com/Home. Accessed 3 December 2007.

[6] US Army Corps of Engineers, Engineer Research and Development Center. Waterways Experiment Station, Vicksburg, MS. http://www.wes.army.mil/ Accessed 3 December 2007.

ADRIENNE R. MINERICK

Adrienne Minerick is an Assistant Professor of Chemical Engineering at Mississippi State University. She received her PhD and M.S. from the University of Notre Dame and B.S. from Michigan Technological University. Since joining MSU, Dr. Minerick has taught the graduate Chemical Engineering Math, Process Controls, Introduction to Chemical Engineering Freshman Seminar, Heat Transfer, and Analytical Microdevice Technology Courses. In addition, she is an NSF CAREER Awaredee, has served as co-PI on an NSF REU site, PI on grants from NSF and DOE, and is the faculty advisor for MSU's chapter of the National Organization for the Professional Advancement of Black Chemists and Chemical Engineers (NOBCChE). Her research is in medical microdevice diagnostics & dielectrophoresis.

Appendix A

Final REU Evaluation Survey, Summer 2007

1. How well do you agree with the following: The REU Bonds program promotes and facilitates teambuilding.
a. Strongly Agree
b. Agree
c. Neutral
d. Disagree
e. Strongly Disagree

2. I enjoyed having the opportunity to learn from mentors in chemistry and chemical engineering

3. I developed professionally as a result of the REU Bonds Experience.

4. I am well informed about research environments and career options.

5. What did you like most about the professional development aspects of the REU Bonds Program?

6. What did you like least about professional development aspects of the REU Bonds Program and what improvements would you recommend?

*Impressions 1
7. Both chemistry and chemical engineering are equally important to chemical research.

*Impressions 2
8. I have a fair understanding of what the other discipline involves.

*Impressions 3 / Initial Impressions 4
9. I enjoy laboratory research.

*Impressions 4 / Initial Impressions 5
10. I am comfortable performing independent research in the laboratory.

*Impressions 5 / Initial Impressions 3
11. I prefer collaborative / team environments.

*Impressions 6

12. I intend to pursue a graduate degree (Masters or Doctorate).

*Impressions 7
13. I value working with people from different cultures and backgrounds.

*Impressions 8
14. I am self motivated.

*Impressions 9 / Initial Impressions 10 (#12)
15. What are your impressions of research at this time?

16. How satisfied are you with the overall quality of communication between you and your research mentors?

17. How satisfied are you with the amount of supervision provided by your research mentors during the program?

18. How satisfied are you with the research nature of the laboratory activities you were assigned (e.g., not menial labor)?

19. How satisfied are you with your interactions with other participants in the program?

20. What do you like most about your mentors?

21. What do you like least about your mentors and what improvements would you recommend?

22. How satisfied are you with your experience at Mississippi State University?

23. Please provide suggestions for improving the attractiveness of the Bonds program.

24. How satisfied have you been with how the class interfaced with your research experience?

25. How satisfied have you been with your housing?

26. The program activities were appropriate and beneficial.

27. The best part about The Bonds was ...

28. The worst part about The Bonds was ...

29. If the following improvements were made, future Bonds experiences would be much better.

30. Overall, the quality of The Bonds REU Program was:
a. Excellent, b. Very good, c. Neutral, d. Poor, e. Very Poor

Appendix B

REU Evaluation Survey for Workshops, Summer 2007

1. How satisfied are you with the materials provided for this activity?

2. How satisfied are you with your opportunity for questions / input / interaction?

3. How satisfied are you with the quality of the speaker(s), instructor, staff, etc.?

4. This activity changed my initial perceptions.

5. This activity provided valuable information / skills that I will use later.

6. What did you like most about this activity?

7. What did you like least about this activity?

8. What would you recommend to improve this activity?

Appendix C

REU Evaluation Survey for Plant Trips, Summer 2007
1. I feel this plant trip enhanced the REU Bonds experience

2. The plant engineer / tour guide(s) was knowledgeable

3. How satisfied were you with your opportunity for questions / input / interaction?

4. This activity provided valuable insights that I will use later.

5. What did you like most about the trip / tours?