

SUSTAINING A MULTIDISCIPLINARY SUMMER RESEARCH PROGRAM FOR WOMEN UNDERGRADUATES

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Abstract — *The Summer Research Experience for Women Undergraduates (REWU) Program at the University of Cincinnati has flourished since its inception in 1999 through the cooperation and support of faculty mentors across disciplines in Science, Engineering, and Medicine. A unique feature of the REWU program is its multidisciplinary character, with the 15-20 participants each year coming from upwards of 10 majors, and with projects directed by mentors from as many or more departments. Other important features of the REWU Program include the faculty cooperation and collaboration that has made the Program a continuing success, and a required weekly seminar, which helps to unify the summer research experience for all participants. The UC REWU Program exemplifies what can be accomplished by a dedicated group of core faculty and supportive administrators. Here we describe program resources, organization, and results to date.*

Index Terms — *Women in Science and Engineering programs, undergraduate research experiences.*

INTRODUCTION

The Summer Research Experience for Women Undergraduates (REWU) Program at the University of Cincinnati (UC) was established in 1999. It has been sustained since then through the cooperation and support of faculty mentors across disciplines in Science, Engineering, and Medicine. The Program is a project of UC's faculty Women in Science and Engineering (WISE) Committee and is supported financially by the departments of participating mentors, by the Deans of Engineering and Arts & Sciences, and by the Offices of the Provost and the Vice President for Research. The WISE REWU Program is the model for a proposed UC research experience for all science and engineering undergraduates.

One unique feature of the UC REWU program is its multidisciplinary nature. Each year the 15-20 participants span 10 or more majors, and projects are directed by mentors from as many as 14 separate departments in the Colleges of Arts and Science, Engineering, and Medicine (for 2003, faculty from 19 different departments have proposed programs; see Table 1). This differentiates the UC program from many

similar programs being offered at other institutions. This also affects opportunities for program support, since many REWU funding options, such as those available through the National Science Foundation, require a unifying research theme. In addition, the WISE Committee is a volunteer group of faculty with limited resources, especially time. At present UC does not have a unified Women in Science and Engineering Program with ongoing administrative support. There is a newly established Rowe Center for Women in Engineering, but its programs are currently focused mainly on recruiting. Thus the UC WISE Committee has needed to develop strategies both for continuing program support and for effective, efficient program management. These strategies may be of use in setting up similar programs in other institutions. Here we describe the program in detail and explain how it is administered. We also give some assessment data, although the data is limited by the lack of administrative support for collection and analysis.

TABLE 1
REWU DEPARTMENTS, SUMMER 2003

Mentors	Mentees
Allergy and Immunology	Aerospace Engineering
Aerospace Engineering	Biochemistry
Biological Sciences	Biology
Cell Biology	Biomedical Engineering
Cardiothoracic Surgery	Biopsychology
Chemical Engineering	Chemical Engineering
Chemistry	Chemistry
Civil & Env. Engineering	Computer Engineering
Developmental Biology	Environmental Studies
Elec. & Computer Engineering	Mathematics
Geology	Middle Childhood
Industrial Engineering	Pre-Pharmacy
Mathematics	
Mechanical Engineering	
Nephrology	
Pediatrics	
Pediatric Psychology	
Pharmacy	
Physics	

PROGRAM HISTORY

As noted above, the UC REWU Program is a project of the faculty WISE Committee. This Committee was established

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in 1997 by a UC Faculty Development Grant and initially consisted of five faculty, from Physics; Geology; Electrical & Computer Engineering and Computer Science; Mechanical, Industrial, and Nuclear Engineering; and the Center for Women's Studies. After discussion and consultation with the directors of successful WISE programs at other institutions, the WISE Committee decided to target undergraduate initiatives, since these would fit well with University initiatives to increase the number of undergraduates overall and to improve the quality of undergraduate life. Thus the Committee planned a pilot undergraduate research program for Summer 1999. Designed to be more than just "placing students in labs", the program would contain three major components:

- a 10-week research project in a faculty lab, with a stipend of \$3000, culminating in a formal written report and project presentation (later increased to 12 weeks, with a stipend of \$4000);
- a weekly seminar series where participants would be able to interact with each other and with research mentors and WISE committee members and where they would also learn valuable skills, such as how to write a scientific abstract and how to read a research paper;
- a final project presentation at a level which would be suitable for a research conference (although, since the students were beginning researchers, the results obtained might be preliminary).

WISE Committee members designed the program to provide the undergraduate women participants with some basic research skills and also to make them aware of opportunities for careers in research. This effort would thus address the underrepresentation of women in most fields in science and engineering. During the first summer, administrative tasks were carried out by the committee itself, with help from some committee members' departments.

Initially it was planned that student participants would be placed two to a department to ensure that each had some peer support on a day-to-day basis. To ensure commitment from the faculty mentors and their departments and to provide the student stipends, each department was asked to provide the stipend for one of these students. The other stipend would be provided by funding from the UC Provost's Office. Overall, this strategy was successful, with some departments providing more than one stipend and with every department providing at least half of one stipend. Support was also obtained from the Deans of the Colleges of Engineering and of Arts & Sciences. During the first summer, eight students participated, with faculty mentors from the Colleges of Arts & Sciences and Engineering, and a somewhat informal research seminar was held at the end of the program. Although a formal assessment was not completed, the students and mentors were for the most part enthusiastic, and thus the WISE Committee decided to continue the program the next year, with some improvements.

Recently the WISE Committee, which has now grown to include 13 faculty and 3 administrators, completed student selections for Summer 2003, the fifth successful year of the program. This year 18-20 students, selected by the WISE Committee through a formal competitive application process, will be introduced to science, engineering, and medical research. Available projects were offered by faculty in 19 different departments (Table 1). Many of these faculty members had mentored students successfully in previous years and were eager to participate again. The program has become a valued regular activity on the UC campus.

PROGRAM ORGANIZATION AND ACTIVITIES

Administrative responsibility for the REWU program still lies with the faculty WISE Committee. For the past three years, the committee has also had administrative support from a university staff member, either in the College of Arts & Sciences or in the Provost's Office. About half the program funding, almost 95% of which is used for student stipends, is provided by the Provost's Office. The remainder is obtained through matching grants from the departments of participating mentors, with small sums coming from the Deans of Engineering and Arts & Sciences.

Planning for the program begins in January, when the WISE Committee members ascertain that funds will again be available and begin soliciting project abstracts from the Science, Engineering, and Medicine departments. Projects are obtained both through department heads and from individual faculty. Brochures, handouts for departments, and the WISE web page are used to advertise the programs. Beginning in late January, WISE Committee members also visit targeted science, engineering, and mathematics classes to advertise the program. Student applicants are required to submit a statement of purpose, transcripts, and two letters of recommendation, and are required to contact the faculty mentors with whom they wish to work. After initial application screening, prospective mentors are contacted by the WISE Committee to ensure that they are willing to work with the students who will be assigned to them. While some students will work for faculty in their major departments, many students also choose projects in related departments, with, for example, a chemistry major opting for a chemical engineering project or *vice versa*. In addition, many students are drawn to projects in the College of Medicine, which does not have undergraduate majors. Typically students will have a grade point average of at least 3.0/4.0. Students must also be willing to commit their summer to the program. Additional employment is not allowed, and requests to take several weeks off for activities such as a family vacation are also not looked on favorably. Applicants majoring in the sciences tend to be rising juniors or seniors, but applicants from engineering are often still in their freshman year. This is the result of the mandatory coop program in engineering, which has the effect that, by the end of their sophomore

year, most engineering students will be settled into industry jobs. Students are chosen for the program by the WISE Committee, which weighs student interest in research, commitment to the program, and reference letters, along with grades and difficulty of courses attempted.

Students in the program are expected to spend 40 hours per week at their research duties and to attend the weekly seminars, usually held on Tuesdays. Many, of course, spend much more time in their labs. Each student is assigned to a particular research mentor. Although graduate students in a lab will often help with the mentoring, the mentor is expected to interact with the student and to attend some of the program activities, including the introductory lunch on the first day, the mentor-mentee training workshop held near the beginning of the program, and the final presentation. Many mentors also assist with the weekly seminars, especially the practice presentations, where students receive specific individual feedback.

The weekly seminars are designed to provide a community for the REWU students and also to give them help with specific skills they need to be successful in their summer projects. Presentations by current graduate students and REWU participants from past summers, as well as a specific presentation on graduate school, provide useful information on planning for research careers. A complete list of the weekly activities is given in Table 2. The Mentor-Mentee Workshop is discussed in more detail in the next section.

TABLE 2
WEEKLY ACTIVITIES, SUMMER 2002

Week	Activity
1	Introductory Lunch (First Day of Program)
1	How to Read a Scientific Paper
2	Library Reviews, Bibliography
3	Mentor-Mentee Workshop (Half-day Activity)
4	How to Write an Abstract
5	Technical Writing
6	How to Present a Scientific Paper
7-8	Progress Report Presentations (2 Parallel Sessions Each Week)
9	How to Write a Press Release
10	Graduate Student Panel (Includes Participants from Prev. Year)
11	Next Steps--Graduate School, Interviews, Financial Aid
12	Rehearsal for Final Presentations
12	Lunch & Final Presentations (noon--4 p.m.)

Because of the multidisciplinary character of the UC REWU program, the final professional-level presentation that the students give to a wide audience, including University Administration, potential funding donors, family members, and, of course, their mentors and fellow mentees and other interested individuals, is a major unifying focus of the program. Because of the diversity of student majors and research projects, the presentations place a great deal of emphasis on communicating complex research results to an audience from a broad range of technical backgrounds. Students must, of course, master large amounts of technical material and experimental procedures. They must also develop a deep understanding of their projects in order to

explain their results to their summer peers and their mentors. To accomplish this task, students must truly become immersed in the work they have undertaken.

A very important feature of the REWU Program is the faculty cooperation and collaboration which has made the program a continuing success. Particularly impressive are the efforts of the individual mentors, who design research projects that undergraduates can complete during the 12-week program, and then supervise their bright and committed but often technically unsophisticated student mentees.

MENTOR WORKSHOP

For most of these students, the REWU program is the first experience of doing research and fitting into the organizational environment of a laboratory, and this sometimes has a negative impact on their overall experience. In addition, research advisors occasionally misjudge the undergraduates' abilities, giving them either too much or too little responsibility. To ameliorate these difficulties, in Summer 2001 a Mentoring Workshop, based on the WEPAN Mentor Training Curriculum [1] was added to the REWU program. This Workshop is now also offered periodically to women graduate students and their research advisors as an aid to developing the mentor / mentee aspects of their relationship [2].

While the Workshops are focused on mentoring for research, they also promote the idea of seeking out multiple mentors and improving the students' own mentoring skills. They are also low key and designed to be nonthreatening to advisors. Discussion is steered and focused by the facilitators, who are WISE Committee members, but the interactive format of the Workshops gives the participants the opportunity to teach themselves and each other how to improve mentoring and mentee skills.

The Training Curriculum materials [1] used in the Workshop are targeted mainly towards mentoring for undergraduate students, particularly by engineers working in industry, but the Curriculum is very complete and flexible, and it does include some specific materials for research advisor / student mentoring. We have found that a Workshop schedule of 2-3 hours works well, with a break after about one hour for refreshments. During the first hour, both mentors and mentees are present. During the break, mentors fill out evaluation forms. The remainder of the Workshop is for the mentees alone. Two WISE faculty members serve as facilitators, and a faculty member who is not on the WISE committee collects survey forms from both mentors and mentees and provides a summary evaluation. The format is informal, encouraging active participation from all participants, rather than formal and scripted. Each participant receives a notebook containing excerpts from the Training Curriculum to use during the Workshop and also to use as reference material after the Workshop is over. The Workshop format is very dynamic and includes discussions

by the whole group, discussions in smaller groups, and role-playing.

ASSESSMENT

Informal assessments imply that the REWU Program is working well. Many students apply each year because they have heard high praise from past participants for the program. Most department heads regularly agree to provide stipends for students, even in tough budget years, as do upper-level administrators. Most mentors offer projects in repeated years. And there are many examples, although they are not formally documented, of participants who have gone on to graduate research programs, at UC or elsewhere, and who have been included as authors on conference and even journal publications. Several participants have also given presentations at professional conferences.

As for formal assessment, every year a survey questionnaire must be completed by each participant. The survey questions for Summer 2002 are shown below (Figure 1).

In future the WISE Committee will also solicit more formal feedback from the mentors themselves and also hopes to be able to track the REWU participants.

QUESTIONS

As the program has grown, various issues have arisen both in how students are chosen and in how to improve ongoing activities. For example, the Mentor-Mentee Workshop was added partly to assist both students and faculty in setting realistic goals for the summer program. Other questions which we are studying at the present time include:

How can we increase informal interactions and peer mentoring among the student participants at the weekly lunches? Student surveys taken at the end of the program indicate that many students interact only with students in neighboring labs, even at the general weekly meetings. They would prefer activities which would lead to more open discussion. Other students would like more planned activities at these weekly meetings. How to make the informal parts of these meetings more effective is one issue the WISE Committee is currently addressing.

How can we better serve the minority students in the program? The UC Engineering College has a well-established program for Emerging Ethnic Engineers (E³) which has a good record both in increasing the diversity of the undergraduate engineering program and in nurturing many student leaders in academic and extracurricular activities. The WISE Committee is exploring ways to add some of the successful activities developed by this program to the Summer Research Program activities and also to do more effective recruiting of the students in the E³ program into the REWU program.

Should we give lower priority to applicants who are planning to become medical doctors rather than researchers? One big motivating factor for maintaining the

REWU program is to help increase the proportion of women in science and engineering research. At present this is not so great a problem among medical students as it is in disciplines such as computer science, mathematics, physics, and most branches of chemistry. If the number of applicants to the WISE program continues to grow, it may be that applicants will need to be more definitely focused on research careers to be successful candidates for the program.

Should we encourage more applications from students studying education, who may not plan to do research themselves but who could have a big impact on whether their future students, both men and women, consider research careers in science and engineering? At present we are accepting students who plan to be K-12 teachers rather than researchers. For the future teachers, we believe that a program like ours can be a real eye-opener about what technical careers are really like, and thus our program can have a magnified effect through the expanded visions of these participants as they deal with their classes in future years. We have also seen students change their career goals to include research as a result of this program, and of course many of these students will have a variety of careers during their lives, some of which may include technical research.

How can we attract more engineering students? In most engineering disciplines, the number of women going on to graduate research programs is still extremely low. At UC all undergraduate engineers must participate in the mandatory coop program, which places them in industrial positions, with higher stipends than the REWU program can offer, for the most part. Thus the number of engineering students applying to the REWU program is low, and many of those students have just finished their freshman year and are thus limited in the kinds of research projects they can undertake. The REWU program does now have authorization to count the summer research experience as a coop quarter, so it is hoped that more engineering students will opt for it. The comparatively low level of the stipend offered is still a matter of concern, however.

How can we obtain more permanent funding for student stipends and better administrative support? This is an ongoing concern of the WISE Committee, not only for the REWU program, which is popular with students, faculty, and administration, and has thus received steady support, but for other fledgling or proposed WISE programs such as K-12 outreach and faculty and graduate student mentoring.

How can the REWU programs be extended to serve other student groups? While the WISE REWU Program is specifically designed to increase the numbers of women opting for research careers in science and engineering, there are also many male students who would benefit from such a program, and whose talents would be better developed through such an experience. As a large midwestern university, many of whose students are the first in their family to go to college, UC would benefit from extending undergraduate research opportunities to a broader audience. The UC administration has expressed interest in such an

expansion, but at present tight budgets are making progress in this area difficult. One possibility to serve more students would be to increase the number of women in the summer program. However, the weekly seminar, which is an integral part of the overall experience, would likely become a very different experience. Many participants want the seminar program to become more open and participatory, but a larger seminar would necessarily become more formal and rigid, and there are not enough WISE Committee members to staff two seminars on a regular basis.

Should the program be expanded to serve students outside the UC community? Up until now, the WISE REWU program has been specifically for UC undergraduates. Some Committee members believe that it would be more effective if it drew from a wider applicant pool, including students who are registered at four-year colleges in the Cincinnati area. At present, since there are no resources to grow the program beyond its present size, this option will likely remain unexplored.

Open-ended questions inspire more beneficial feedback than those of ranking and sorts. Such questions yield quite unique responses if you answer them honestly and take the time to think about your responses.

1. Most of you mentioned during your presentations that this experience provided by the REWU program has touched your lives. Please summarize several aspects and experiences this program has provided you that you may not have otherwise experienced. How do you value these experiences?

2. If you had the opportunity to redo this program, what would you change on your part?

3. Has this program met the expectations you had of this opportunity? How or how not?

4. Would you recommend this program to a friend? and why?

5. Did you find the Tuesday meetings helpful?

6. Which activities done within this group did you find most and least meaningful? Explain.

7. During the Tuesday meetings, several topics were discussed. Which of the topics related best to your academic careers or needs? What other kinds of discussions or topics do you wish were addressed?

8. During the twelve-week period, did you feel you were part of a group within the REWU program as well as your research group? What suggestions could you make for unifying the group within the REWU program?

9. Have you left with a greater understanding of the role of scientists within the scientific community (within each department and interdepartmentally)? Has this helped shape your career goals and educational aspirations?

FIGURE 1

SURVEY QUESTIONS, SUMMER 2002

CONCLUSIONS

Since its inception in 1999, The University of Cincinnati Summer REWU Program has doubled the number of undergraduate UC women being introduced to serious scientific and engineering research each summer and has fostered the research careers of several participants. Its WISE Committee organizers remain enthusiastic about the program, as do its participants and its supporters in the UC Administration. It continues to seek more permanent funding.

REFERENCES

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