AC 2007-2381: FACTORS FOR AN EFFECTIVE LSAMP REU

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Factors for an Effective LSAMP REU

Abstract

A Louis Stokes Alliance for Minority Participation (LSAMP) Research Experiences for Undergraduates (REU) program has been offered for two summers by the National Science Foundation (NSF) Engineering Research Center (ERC) for Wireless Integrated MicroSystems (WIMS). For three previous summers, a WIMS REU was offered; thus WIMS has operated an REU for a total of five summers. This paper provides a view of the design and components of the WIMS LSAMP REU, and successes of the REU students to contribute to the WIMS research programs, as well as to pursue graduate study and earn graduate degrees. Alliances with LSAMP chapters at minority serving institutions (African-American, Hispanic, and others) have been important to the recruiting effort. WIMS REU'ers have gone on to graduate study and professional schools in significant numbers (about 80%). An independent third-party process evaluation has been done each year, leading to continuous program improvements.

Introduction and Overview

WIMS ERC Structure: WIMS is a National Science Foundation (NSF) Engineering Research Center (ERC) with initial core partner universities of the University of Michigan – Ann Arbor (UM), Michigan State University (MSU), and Michigan Technological University (MTU). During its seven year duration, WIMS now has outreach faculty at partner universities of Prairie View A&M University, University of Puerto Rico – Mayaguez, North Carolina A&T State University, Howard University, University of California – Berkeley, and University of Utah. WIMS has about 15 industry partners (small, medium, and large sizes) including Motorola, Freescale, Schlumberger, Stryker, Agilent, Medtronics, etc. Of course, NSF is the major partner and each university contributes substantial internal funding. WIMS is structured with nine areas consisting of five Research Thrusts: (r1) Biomedical Sensors and Subsystems, (r2) Environmental Sensors and Subsystems, (r3) Wireless Interfaces including MEMS, (r4) Micropower Circuits, and (r5) Advanced Materials, Packaging, and Processes; two engineered systems testbeds: (t1) Neural Prostheses, and (t2) Environmental Monitoring; an Education Programs Thrust; and an Industrial Liason for external and industry relations.

Education Programs Thrust Structure: The goals of the WIMS Education Programs Thrust are to educate the next generations of engineers and scientists about WIMS and with WIMS, and to rapidly transfer results from the research domain to the classroom domain. Proactive diversity and outreach initiatives, as well as evaluation, are to be integrated within each program. As depicted in Figure 1, the Education Programs Thrust provides comprehensive opportunities with three sub-components: pre-college programs for K-12 students, university programs for undergraduate and graduate students, and professionals / society programs for practicing professionals and general society.

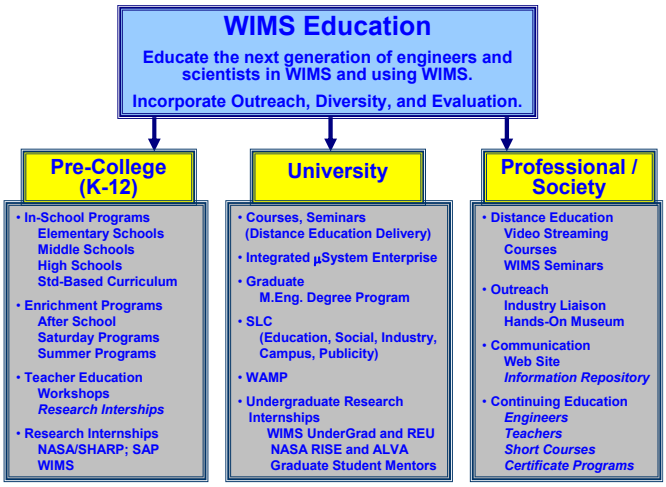

Figure 1 – Comprehensive Scope for WIMS Education Programs.

University Education Structure and Programs: The strategy for the WIMS university education programs is to provide courses, research opportunities, mentoring opportunities, access to industry relationships (such as internships and professional collegial relationships), and management/supervisory experiences. One goal is to have as many undergraduate students involved in research and major design experiences as there are graduate students. A description of the courses available was reported at ASEE 2006[1]. The WIMS LSAMP REU program is one such program to directly engage undergraduate students in pioneering research experiences with mentoring by advanced graduate students and internationally renown faculty members.

WIMS LSAMP REU Program Components

Numerous factors are part of the LSAMP REU. The WIMS LSAMP REU has a dominant primary component, several secondary components, and ancillary components. Table 1 has a summary list of those components. The WIMS LSAMP REU Program is a 10.5-week residential program for LSAMP students located at at the University of Michigan.

Table 1 –
WIMS LSAMP REU Components

Primary Component
Research Projects, with mentoring
Secondary Components
Communication Skills
Professional Ethics
LSAMP Awareness
Graduate Study Workshops
Ancillary Components
WIMS Seminars and Discussions
Field Trips and Tours
Interact with other Research Students

REU programs significantly enrich the educational experience of participating undergraduate students and have great potential to influence decisions of students to pursue graduate study[2-6]. Also, REU programs provide an environment for professional connections and networking with influential colleagues and leading researchers. Students learn first hand the satisfying rewards of frontier research endeavors whose achievements and advances benefit society. For students that attend universities with a teaching mission primarily, the LSAMP REU has had the added importance of being a research "eye-opener" experience. Often an unstated factor is the benefit for graduate students to gain research project management (including research project planning with timelines and budgets, personnel supervision, technical assessment and leadership, and mentoring).

WIMS LSAMP REU Primary Component --- Research Projects with Mentoring

The WIMS LSAMP REU is structured with the primary goal of a research project experience. Each student has a research project with a strong involvement with one of the research thrust teams, working directly with an advanced graduate student or post-doc or system integrator (usually in meaningful daily contacts) under the direction of a WIMS faculty member. Each REU research project has a clearly defined project goal that the REU student could accomplish during 8 to 9 weeks of diligent work, recognizing that the REU student must first develop a knowledge base in the research area. The REU projects are developed such that the results would benefit the research project being conducted by the mentor, ensuring genuine enthusiastic interest and assistance by the mentor. LSAMP students have had projects in all five research thrust areas and both testbeds.

Graduate students and faculty are matched with selected LSAMP undergraduate students using at least three approaches. Each undergraduate applicant is asked to indicate her/his individual areas of research interest in a short essay (500 words or less), as well as check-off research areas on the application form; this information is used for tentative student/mentor matching. A second approach is having projects suggested by WIMS faculty with their graduate students. Some faculty indicate a general request for an undergraduate student, and do not prepare a detailed project until after meeting and discussing mutual interests with the undergraduate student. Other faculty indicate the specific project that an undergraduate student would work. Often, a third approach is the LSAMP REU Director asks faculty and/or graduate students if they have a project that would approximately match an individual area of interest that has been indicated by an undergraduate applicant. With each approach, the proposed match of an undergraduate applicant with a WIMS graduate student and faculty is discussed and consensus reached during the weekly WIMS Administrative Group meeting.

The WIMS LSAMP REU research projects proceeded smoothly for both summers, with strong support of faculty and graduate students working closely with the undergraduate students. These students worked tirelessly, had high personal achievement goals, and cherished the challenge to acquire new knowledge, to conduct research in a pioneering area, and to make research contributions. An example of an undergraduate fertile mind is a publication that resulted from the idea of an undergraduate[7].

Some Observations: High academically achieving students that have completed two university years are able to contribute to and benefit from WIMS undergraduate research. Second year students have few or no courses in their major area; however, the students have good science and math backgrounds, high levels of commitment and energy to learn, and strong inquisitive minds. Of course, high achieving third year and fourth year students are even better candidates.

Students majoring in science areas are able to contribute to and benefit from WIMS undergraduate research. Most of the students of the WIMS Center are engineering students, though many of the students have science backgrounds, either due to an undergraduate science major or due to science core courses in their engineering major. For summers 2005 and 2006, six of the science students joined the WIMS Center and worked suitably on research projects related to their major and to their planned career interests.

WIMS faculty and graduate students can mentor and provide research projects appropriate for second year to fourth year students and for science majors. Students with sophomore status and science majors were concerns prior to and during the early stages of summer 2005. However, our concerns were significantly reduced because the LSAMP REU students worked tirelessly, had high personal achievement goals, and cherished the challenge to learn new research fields and then conduct undergraduate research in the new fields.

WIMS LSAMP REU Secondary Components

Communication Skills Component: A communication skills instruction component, structured to be in parallel with and to document the research project, has three segments: a project description, a progress report, and a final report. A faculty member of the UM Technical Communication Program provides class instruction, assigns homework, and provides extensive feedback after first drafts of reports and oral presentation practices.

During the first segment, and after the student has been involved for about two weeks becoming familiar with the research project, each student writes a project description of the research to be conducted during the following eight weeks. The project description contains a project title, project goal, review of literature, research methods, tasks, timeline, linking of the WIMS research thrust with the student's research project, and an explanation of the REU student's project role and contribution to the success of the graduate student mentor's research, as well as the WIMS ERC research mission. A first draft is prepared with feedback provided by the instructor and the research mentor; then a second draft of the project description is prepared. Thus, at the end of the first segment, the REU student should have clear understanding of the anticipated tasks for the research project; and the mentor should know the understanding of the REU student.

During the second segment, the assignment is a progress report of the research project; including any project modifications after the project description. Each student writes one progress report that could serve as an early first draft of the final report. Also, each student prepares and makes an oral presentation of four to six minutes to verbally explain the progress report (providing oral presentation practice prior to the Closing Symposium).

During the third segment, a final written report and oral presentation were the major objectives. Each student prepares a first draft of the final report, then receives comments/consultation from other REU colleagues, his/her graduate student and faculty mentors, and the technical communication instructor. Then a second draft of the final report is prepared. After completing the final written report, each student prepares a PowerPoint oral presentation of the final project results, scheduled to be approximately 10 minutes long, plus 5 minutes for questions. The actual final oral presentations are made during a Closing Symposium. Mentors, faculty, family, and friends attend the symposium.

Impact of Process Evaluations for Communication Skills Component: One noteworthy modification was done due to evaluation. In previous years, REU students, graduate students mentors, and faculty advisors made comments that the communication skills component should have less intense focus, and the comments were borne out in the evaluator's report. The mid-term progress report has been re-structured to receive less emphasis with a single draft written report and an oral rehearsal. Otherwise, the technical communication component has continued its high level delivery and support of the research project. Overall, the students have evaluated the communication skills component as highly important.

Professional Ethics Component: The WIMS REU professional ethics component has goals to advance student awareness of professional responsibility, and for each student to apply ethical reasoning and principles to his/her REU research project (and in personal situations). The professional ethics portion informs the students about ethics and professionalism. The staff for Professional Ethics are two persons with extensive experience teaching ethics as a topic in a class, and teaching ethics as a topic embedded in engineering classes. Also, ethics concepts and dilemmas are entered into LSAMP awareness presentations. Each ethics session has a presentation followed by open discussions by students and presenter.

Two presentations are on (1) Morality and (2) Engineering Codes of Ethics. Ethics examples and case studies are drawn from the microsystems, microelectronics, and MEMS fabrication areas. Of special note for these presentations are ethics issues and discussions related to the research projects of the WIMS LSAMP REU students.

Another three presentations are on (1) Steps in Ethical Decisions, (2) Ethical Dilemmas as Students and Professionals, and (3) Case Studies and Ethical Responsibility. At UM, regular Chemical Engineering courses have these ethics topics embedded. During the three presentations, traditional ethics topics are discussed focused with attention capturing examples related to engineering professionalism. Students are introduced to (1) the concept of professionalism and professional codes of ethics, (2) the relevance of professionalism to engineering, (3) the origin of ethical dilemmas and how they arise in professional practice, (4) the use of practical experience to resolve ethical dilemmas, (5) the impact of engineering on society, (6) specific responsibilities engineers generally recognize, such as responsibility to the public, (7) six steps to reach a decision about ethical responsibility, (8) an introduction to ethical reasoning skills, (9) STS (science, technology, and society) studies, and (10) initial exploration of the impact of WIMS research on society, consistent with STS studies, with examples drawn from WIMS MEMS and microsystems research areas.

Impact of Process Evaluations for Professional Ethics Component: The format of presentation and discussion was introduced for Summer 2005, responding to evaluations and student comments about the ethics component for summer 2002 to summer 2004. For summer 2005 and summer 2006, the Professional Ethics portion aimed to inform the students about ethics and professionalism, with dilemmas providing a catalyst for discussions. The format has received acceptance by LSAMP students, according to the evaluation reports.

LSAMP Awareness Component: LSAMP Awareness component has goal to help inform the students about the program in which they are participating, including Hispanic contributions and LSAMP history. History and culture aspects related to race, ethnicity, and LSAMP developments (creation, evolution of goals, and growth in participants, graduates, and chapters) are included. The LSAMP Awareness component provides information about underrepresented minority contributors and the growth and achievements of LSAMP students. The Summer 2006 edition included richer LSAMP information, facilitated by materials provided by Dr. A. James Hicks, LSAMP Program Director at NSF.

The presenter for LSAMP awareness was a high school teacher of English, Drama, African American Literature and History, and Speech in the Ann Arbor Public Schools. She made two presentations plus led a narrated guided tour of the newly created "With Liberty and Justice for All" exhibit at the Henry Ford Museum. Her two presentations were on (1) History and Dilemmas of Ethnic and Racial Minorities (especially African and Hispanic Americans including King/Chavez/Parks (KCP)), preceding the tour of the Henry Ford Museum exhibit, and (2) From KCP to LSAMP, a presentation that documented the growth and development of LSAMP as a national resource, and the tremendous growth and achievements of LSAMP students since 1991. Using the much appreciated resources of conversations with Dr. Hicks and materials he provided, tremendous wealth of materials and discussion topics were available. PowerPoint slides were developed and the chronology and achievements of the LSAMP organization and LSAMP students were presented with great pride and enthusiasm. Both presentations include dilemmas of racial and ethnic leaders in advancing goals for underrepresented minorities, thus raising the legal and ethical dilemmas faced by past and present civil rights leaders.

Impact of Process Evaluations for LSAMP Awareness Component: The feedback from students and the evaluation for Summer 2005 revealed a need to provide richer LSAMP information. The Summer 2006 sessions has more focus on contributions leading to the development and growth of LSAMP programs. Dr. Hicks kindly responded effectively to requests for written LSAMP information, along with highly informative phone conversations.

Graduate Study Sessions and Related Tours: Graduate study workshops inform students about identifying and choosing graduate programs for themselves, the graduate school application and admission process, financial awards, and exciting enjoyable professional careers in research and academia. Eight presentations are made by a staff of two (2006) or three (2005). The author (of this paper) makes presentations on selecting graduate schools, financial awards, the admission process, GRE requirements and preparations, motivation for graduate study, and research and academic career opportunities. Presentations have included

some Massachusetts Institute of Technology (MIT) videos on the life of a graduate student; in summer 2005 the MIT material was provided in two presentations by the author's daughter (a recent PhD graduate in Chemical Engineering at MIT and a CASEE Post-Doc conducting research on motivation for minorities to enter graduate study in science and engineering); in Summer 2006, the author made presentations using the videos his daughter shared. The MIT videos were produced by the Office of Minority Education at MIT.

Another full afternoon of graduate study sessions and related lab tours are led by a Professor at Michigan State University; the students travel to the MSU campus. The MSU graduate study sessions have a mix of tours that include academically informative presentations about labs and current research projects, as well as presentations about graduate study processes and financial support with special note of MSU opportunities. Their lab tours are custom tailored to match the major areas of the LSAMP REU students; for example, for summer 2005, the tours were more biology and chemistry oriented; whereas the summer 2006 tours had engineering emphasis. Summer 2006 lab tours included (1) the Robotics Lab, (2) the Non-Destructive Evaluation Lab, and (3) Fraunhofer Center materials processing lab facilities; Summer 2005 lab tours included (4) the Genomics Center and (5) the Diagnostic Center for Population and Animal Health (a State of Michigan facility). In addition to the tours, presentations have been made about graduate study leading to exciting research and faculty careers, and several faculty and graduate students have presented and discussed graduate study opportunities specifically at MSU.

All WIMS LSAMP REU students plan to pursue graduate study. Several students plan to attend United States graduate schools that are internationally renowned. Due to strong family ties (and financial considerations), some students plan to attend universities that are geographically local to their family home. For any WIMS LSAMP REU student completing undergraduate studies, the WIMS REU will pay the fees associated with gaining admission to graduate study for up to three graduate schools (GRE registration fee plus application fees).

Graduate study is early for the WIMS LSAMP students; Fall 2007 enrollment is the first time to gather meaningful information. However, in the previous REU program for summers 2002 to 2004, in which almost all the participants have earned the bachelor degree, 23 of 30 students entered graduate study right after earning the bachelor degree and another entered graduate study within a year after the bachelor degree. Thus about 80 percent of those WIMS REU participants have pursued graduate study. In due time, the WIMS LSAMP REU is expected to boast a similar percentage. Table 4 (later in this paper) has some summary demographics for that WIMS REU program that lasted for summers 2002, 2003, and 2004.

WIMS LSAMP REU Ancillary Components

Ancillary activities to enrich the REU experience consists of tours of laboratories, museum visit(s), social/camaraderie activities, and REU group meetings.

Social opportunities and events are arranged for WIMS LSAMP REU students to interact with students in other related programs and to build a larger community of undergraduate research scholars. At UM, LSAMP REU students have research interactions with other

undergraduates in another WIMS Undergraduate Research (WUGR) program for UM students, and they share housing and personal social activities with WUGR students, as well as National Nanotechnology Infrastructure Network (NNIN) REU students. During the tour of MSU labs and at a dinner meal, WIMS LSAMP REU students interacted with another group of REU students in SuPURBS (Summer Program for Undergraduate Research in Biological Sciences), as well as MSU graduate students. An abbreviated virtual tour presentation of the Michigan Nanofabrication Facility (MNF) at the University of Michigan was arranged, because the lab is undergoing a $48M major renovation and expansion construction. Each year, the LSAMP REU students visit the Henry Ford Museum (a site useful to expose students to microsystems and MEMS historical developments).

A group meeting with REU students and administrative staff is scheduled once each week, usually before or after another class or group event to minimize non-research time. Topics of the meetings include schedule reminders, announcements, financial matters (stipend payment schedule, travel reimbursements), student selection of activities, changes in meal locations for special events, and design of REU T-Shirts. A SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis is solicited at each meeting to learn and respond promptly to student concerns and complaints. The meetings prove to be extremely beneficial.

Student Recruitment, Applicants, and Selection

Recruiting Initiatives: Recruiting (to make students aware of the WIMS REU and to solicit applications) is an on-going effort from early October through early May. An REU web-site exists, as a link at the WIMS web site (www.wimserc.org). The REU web pages have a flyer and an application. Students can acquire the WIMS REU application online, postal service mail, or fax. The completed WIMS REU application can be hand delivered, submitted via postal service, faxed, or emailed as an attachment.

Recruiting contacts are made through many sources. WIMS REU announcements (flyer, web-site information) are sent to contact persons at NSF ERCs and WIMS outreach partner universities. Also, emails are sent to students identified in emails forwarded through NSF. In early Fall, a set of flyers and brochures are provided to recruiters for a UM summer research program; this association is a minor source of applications. WIMS is represented at the Houston LSAMP Symposium in early November, and at the Florida/Georgia LSAMP Expo in late January (February in 2007). And the WIMS Education Director makes a recruiting trip to four schools in the Houston area in early March: University of Houston main campus, University of Houston – Downtown campus; Texas Southern University; and Prairie View A&M University. This recruiting trip produces many excellent applicants.

Applications and Student Selections: Table 2 contains summary information about applicants to the WIMS LSAMP REU program combining both summer 2005 and summer 2006. In all, 33 student applications were reviewed; 32 from students attending universities outside the WIMS ERC. Of the 33 applicants, 29 had academic records (GPA, references, major, interest) and status (entering junior year or above) such that they were deemed academically appropriate for the WIMS LSAMP REU program. Due to Texas legislation, Houston LSAMP does not restrict LSAMP status to underrepresented minorities; a decision

was made to include a few such applicants in the WIMS LSAMP REU. Overall, 18 students were invited to join the program; 4 students declined the invitation, and 1 student was a no show. Declines were for students to attend other REU programs (Purdue, Rice, Virginia, unknown) and a NASA internship; these choices are equally good alternatives to the WIMS LSAMP REU program. Thus, the WIMS LSAMP REU has been very successful in attracting highly sought students. The last 2 columns of Table 2 contain demographics for participants in the two summers of the WIMS LSAMP REU. The count of female applicants and participants is much smaller than the desired goal of about 50%.

Table 2 --- LSAMP REU Applicants and Participants by Gender, Outside/Inside, and Race/Ethnicity

Race Category	Applicants Demographics (#, Gender, Outside/Inside)						REU Participants	
	Total	Female	Male	Outside	Inside	Hispanic	Female	Male
American Indian or Alaska Native	0	0	0	0	0	0	**0**	**0**
Asian	9	2	7	9	0	0	**1**	**3**
Black or African-American	17	5	12	17	0	0	**1**	**3**
Native Hawaiian or Other Pacific Island'r	0	0	0	0	0	0	**0**	**0**
Caucasian	7	1	6	6	1	5	**1**	**4**
Multi-Racial (A/C)	0	0	0	0	0	0	**0**	**0**
Multi-Racial (Hispanic)	0	0	0	0	0	0	**0**	**0**
Non Citizen or PR	0	0	0	0	0	0	**0**	**0**
Totals	**33**	**8**	**25**	**32**	**1**	**5**	**3**	**10**

Table 2 Notes:
PR = Permanent Resident.
Multi-Racial has two categories: (1) A/C for Asian/Caucasian and (2) Hispanic Underrepresented.
Persons identifying themselves as Puerto-Rican are placed in the Multi-Racial (Hispanic) category.
Inside applicants are students at MSU, MTU, or UM; all other applicants are counted as outside.

WIMS LSAMP REU Participants: Table 3 contains summary information about the LSAMP REU students: gender, race/ethnicity, major, year level completed, home university, and graduate school information. All participants are citizens of the United States. In each WIMS LSAMP REU year, the students were enrolled at four different home universities.

Clearly, the WIMS LSAMP REU has different demographics than the previous WIMS REU. The student racial and ethic categories are clearly more directed toward African-Americans and Hispanics; African-Americans and Hispanics constitute more than 69% in the WIMS LSAMP REU, though only about 33% in the WIMS REU. The gender make-up for the WIMS LSAMP REU needs larger female participation. The academic major was largely science for summer 2005, and largely engineering for summer 2006, with science majors slightly larger than engineering majors for the combined two years. A notable change is that science majors have constituted 53.85% for the WIMS LSAMP REU, while the previous WIMS REU had about 3.33%. Engineering majors have constituted about 46.15% for the WIMS LSAMP REU, while the previous WIMS REU had 90%. Also, academic level (years completed) sees a remarkably different make-up: students completing only 2 years constitute about 53.85%, while the previous WIMS REU had about 36.67%; students completing 3

years constitute about 38.46%, while the previous REU had about 30%; students completing 4 years constitute about 7.69%, while the previous REU had about 33.33%. Perhaps these comparison percentages reflect that engineering majors often take more than four years to earn the bachelor degree. Table 4 shows these comparisons in table form, with counts and percentages.

Table 3 --- Demographics of LSAMP REU Participants for Summer 2005 and Summer 2006, Plus WIMS REU Summary for Summers 2002 to 2004 --- Gender, Race/Ethnicity, Academic Level, and Academic Major

Category	Summer 2005 (LSAMP REU)	Summer 2006 (LSAMP REU)	Summers 2002 to 2004 REU Programs
Totals	7	6	30
Female	1	2	13
Male	6	4	17
African-American	2	2	7
Hispanic (Caucasian)	3	2	3
Mixed			1
Other (Asian, Caucasian)	2	2	19
2 Years Completed	5	2	11
3 Years Completed	2	3	9
4 Years Completed		1	10
Biology	1	1	
Bio/Chem/Phys Sci	2	1	
BioMedical Engin			2
Chemical Engin			2
Chemistry	1		
Civil Engin	1	1	
Computer Engin	1		4
ElecEng&CompSci			2
Electrical Engin		3	16
Mechanical Engin			1
Physics	1		1
Other			2
Home Univ Count (Outside + Inside)	4 + 0	3 + 1	11 + 3
Enroll Grad/Prof Sch	1	NA	24
Likely will Attend Grad/Prof School	6	6	

Table 3 Notes:
1. Race/Ethnicity:
   Other includes Non-Hispanic Caucasian- and Asian-Americans.
   Mixed is person with one parent an underrepresented minority.
2. Inside applicants are students at MSU, MTU, or UM; all other applicants are counted as outside.

Table 4 --- WIMS REU vs WIMS LSAMP REU Comparison: Gender, Race/Ethnicity, Academic Level, and Academic Major		
Category	WIMS REU Summers 2002 to 2004	WIMS LSAMP REU Summers 2005 & 2006
Totals	30	13
Female	13 (43.33%)	3 (23.08%)
Male	17 (56.67%)	10 (76.92%)
African-American	7 (23.33%)	4 (30.77%)
Hispanic	3 (10.00%)	5 (38.46%)
Mixed	1 (3.33%)	
Other	19 (63.33%)	4 (30.77%)
2 Years Completed	11 (36.67%)	7 (53.85%)
3 Years Completed	9 (30.00%)	5 (38.46%)
4 Years Completed	10 (33.33%)	1 (7.69%)
Engineering Major	27 (90.00%)	6 (46.15%)
Science Major	1 (3.33%)	7 (52.85%)
Other Major	2 (6.67%)	

Evaluation Information

For each of five summers (2002, 2003, 2004, 2005, and 2006), a non-university, third-party, independent evaluator has conducted a process evaluation. This paper has an abbreviated discussion of evaluation results. Process evaluation was recommended and approved as being especially valuable and effective in the first year; moreover, the evaluator recommended continuation of process evaluation during the other summers.

The evaluation plan has three phases. Phase 1 comprised interviews of REU administrators, a faculty research advisor, and a graduate student mentor. Phase 2 encompassed entry interviews of all REU students, three graduate student mentors, and a faculty mentor. During the program, the evaluator attended one instruction session of communication skills, reviewed samples of students' written products, attended a professional ethics presentation, attended an LSAMP awareness session, and attended the Closing Symposium. Phase 3 included exit interviews of REU students, and post-program interviews of graduate student mentors and faculty.

Student feedback is a major feature in evaluation reports. Such feedback is obtained especially during exit interviews (and somewhat during entry interviews). Examples of process evaluation suggestions that were based on student feedback are:

- Schedule mentor-the-mentor sessions prior to the start of each summer program.
- Significantly revise the professional ethics component (summer 2002).
- Start sessions at 9 AM, instead of 8 AM.
- Use former students to serve as ambassadors to promote the LSAMP REU; also, continue recruiting visits by the Program Director.

The evaluator reported that student expectations are met (for the most part) by the WIMS LSAMP REU, including factors such as:

- Exposure to cutting edge research;
- New skills and knowledge;
- Opportunities to network;
- A close look at life as a graduate student;
- Experience working with a research mentor;
- Access to outside letters of recommendation; and
- Real-life research experience.

After Summer 2006, the evaluator recommended that the following areas should be considered:

- Research projects: (1) List projects on the WIMS web-site. Students would like to know more about tentative research projects, to match their interests to pending research projects, and to conduct background research prior to joining the WIMS REU summer program; (2) mentor training should emphasize the importance of the mentor to help LSAMP students assimilate to a new research culture and that their words and actions are key to the REU program success; (3) both mentors and students recommended pairing students with projects before their arrival on campus; (1) WIMS faculty and graduate students would like students that have completed their junior year, with a larger number of major area courses in their background; (2) LSAMP REU students made contributions to research results; and (5) mentors asked program administration to procure additional lab space for LSAMP students (this recommendation has not appeared previously).
- Technical Communication Instruction: Students acknowledged the value of technical communication, though hesitantly for some, and some thought the written assignments were not clearly presented. The oral presentations instruction was favorably received.
- Ethics Presentations: Similarly, students hesitantly acknowledged the value of ethics to their education.
- LSAMP Awareness: The evaluator assessed LSAMP awareness as part of the ethics component (2005 format); it was favorably received.
- Graduate Study Sessions: The LSAMP REU program (1) had a positive effect on each student to pursue graduate school; (2) informed them about funding opportunities; and (3) had increased their confidence to pursue graduate study. Students emphasized the career and decision making assistance gained during exposure and the workshops presented during the REU program.
- Tours: The tours were received highly; the tour of the Michigan Nanofabrication Facility was rated much higher than the other tours.
- Peers: The LSAMP REU students felt very positive about their peers, and planned to remain in contact with the other students. Except for one student, LSAMP REU students planned to remain in contact with their mentor.
- Program Administration: (1) 10.5 weeks is about the right length for the LSAMP program; (2) Entrée Plus meal plan is a more preferred method to provide for student meals, and permits more flexible meal scheduling to accommodate

research needs; however, all students expressed the need for healthier choices and more variety by the end of the summer session (note that campus dining provides variety and healthy balanced nutrition; it is up to the student to select that choice).

- Recruitment: (1) Continue to use recruiting visits to campuses and presentations to recruit students; the recruitment presentation seems to be a deciding factor for several students, allowing personal one-on-one questions and conversation. (2) Continue to develop institutional relationships with LSAMP Directors, and expand the recruitment presentations; (3) Use former LSAMP REU students to assist in the presentations and in recruiting; and (4) The WIMS Web site should provide a more intuitive and obvious link to the undergraduate research programs; this recommendation received high attention. Students cited the WIMS LSAMP REU was among their choices at other prestigious programs at Stanford, Berkeley, MIT, and Purdue.

Some anecdotal information may provide insight about other impacts of the LSAMP REU program. Two students of the Summer 2006 program have indicated that their research projects are really helping them with their classes this academic year. During their analog-to-digital converter research projects, they learned transistor operation, and they are excelling in their transistor classes (at two different universities). A student of the Summer 2005 program reports that her research project (along with her Summer 2006 experience with a national lab) has influenced her to pursue a Ph.D. in Pharmacology and have a research career rather than a Pharmacy degree. Over both summer 2005 and summer 2006 programs, a total of three students have indicated that graduate study is definitely in their plans just after receipt of the bachelor degree. And three other students have indicated that their plans to attend medical school have not been impacted by the WIMS LSAMP REU.

Closing

In closing, LSAMP undergraduate students have had meaningfully important and significant impacts (receiving and contributing) due to their engagement and participation in the effective WIMS LSAMP REU summer programs. The LSAMP is effective because the undergraduates are engaged in pioneering research, the students get a glimpse of the life of a graduate student at a major research university, professional and career networking colleagues are established, students are highly capable, WIMS is able to accommodate science students in addition to engineering students, mentoring is a valuable approach, and most important: undergraduate students have made and continue to make valuable contributions to the WIMS research enterprise.

Acknowledgements

The Engineering Research Centers Program of the National Science Foundation under Award Number EEC-9986866, wholly or partly, supports the WIMS Education program and projects. In addition REU programs are supported through supplemental awards.

Numerous individuals have contributed to LSAMP REU and WIMS REU programs and components. First, thanks to WIMS Faculty and Graduate Mentors for providing engaging research experiences for the selected REU students and for superb mentoring. For communication skills, thanks to Mr. Jack Fishstrom (UM Technical Communication program) for five years of committed instruction, report consultation and feedback that has been strongly appreciated by the students. For professional ethics, thanks to Mr. Fishstrom and Dr. Susan Montgomery (UM Chemical Engineering Department) for their instruction and case studies discussions. For LSAMP awareness, thanks to Ms. Lexy Lyons (Ann Arbor Public Schools Teacher) for her enthusiastic presentations about LSAMP historical developments and achievement, as well as to Dr. A. James Hicks, Director of NSF LSAMP programs. For graduate study sessions, thanks to Professor Percy Pierre (MSU) and Dr. LaRuth McAfee (MIT and CASEE) for their warm informed presentations about graduate study opportunities, career information, and student life awareness; the author made presentations in this portion also. Evaluation acknowledgements go to Dr. Cynthia Koch for her professional process evaluations over five years. Prior to the LSAMP REU, significant administrative contributions and efforts were provided by faculty at MSU (Professors Andrew Mason and Dean Aslam) and at MTU (Professor Paul Bergstrom). Many, many thanks to Ms. Peggy Henderson, WIMS Education Program Coordinator for her staunch support and generous contributions for five years of REU programs, as well as for her careful review and editing suggestions for this paper. And, thanks to the Abstract reviewers and the Draft paper reviewers for suggestions to improve the paper.

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List of Acronyms

CASEE	Center for the Advancement of Scholarship on Engineering Education
CoE	College of Engineering (at MSU, MTU, and UM)
ERC	Engineering Research Center
MEMS	Microelectromechanical Systems
MIT	Massachusetts Institute of Technology
MSU	Michigan State University
MTU	Michigan Technological University
NSF	National Science Foundation
UM	University of Michigan
WIMS	Wireless Integrated MicroSystems