

Fulfilling Mentors' Expectations: An REU Site Experience

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Abstract – Undergraduate research is one of the recommended activities by the National Science Foundation to address several important problems in Engineering education such as dropout and graduation rates and enrollment in graduate programs. These and other problems are particularly acute in under-represented minority groups, the same groups that exhibit the fastest growing population rates in the country. This paper describes our experience running a Research Experiences for Undergraduates (REU) Site in Computer Science and Engineering (CS&E) and provides guidance to run these demanding programs successfully. After describing our REU program unique characteristics and main objectives, the paper describes the most important aspects that need to be considered in these programs. Finally, the attention is focused on the faculty mentors, a sometimes overlooked and important aspect in these programs. An entire section describing in detail how the mentors were evaluated and what aspects need to be considered to fulfill their expectations is included.

Keywords: Research Experiences for Undergraduates, NSF REU Site, mentors, summer research program.

INTRODUCTION

Current statistics and trends in graduation, enrollment and participation of minority groups in Science and Engineering (S&E) are alarming. For example, according to NSF's Science and Engineering Indicators 2002, the enrollment in Engineering has declined continuously from 1983 to 1999 by more than 20% [2]. Furthermore, the National Center for Educational Statistics (NCES) found in 2000 that, although 25-30% of students entering college intend to major in Science and Engineering, fewer than 50% completed their degrees within a 5-year period [9]. The study also notes that approximately 20% of students dropped out of college and that the graduation rate of underrepresented minority students is lower than that of other groups [3].

In recent reports [10, 5], Hispanics are shown to be the fastest growing population in the United States and are projected to be the largest minority group in the country by 2005. However, the reports also indicate that Hispanics only account for 6, 4 and 3 percent of the bachelor's, master's and doctoral degrees, respectively. Further, they are the least-educated major ethnic group, and the group with the lowest graduate school enrollment. There are several important reasons that contribute to making it difficult for Hispanic students to succeed in education. Among the most relevant of these issues is the increase in tuition rates, the lack of Hispanic professors (only 2.9% of full-time college faculty members), the lack of family models, inadequate student services, and poor lower-level education. If this important number of the total population of the country is to contribute to the nation's welfare and prosperity in the future, it is crucial for them to receive help now.

One recommended reform included in the NSF Science and Engineering Indicators 2002 report to meet the challenges of Science and Engineering (S&E) higher education is to increase the involvement of undergraduate students in research [2]. Motivated by these statistics and trends in graduation, enrollment and participation of minority groups in S&E, the authors submitted a REU Site proposal to the National Science Foundation in 2004 to provide students from under-represented minority groups the opportunity to be involved in a 10-week summer research program in Computer Science and Engineering (CS&E). The proposal was funded by NSF for three years and its first completed summer program just finished.

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The objective of this paper is manifold. First, it describes our program and unique characteristics as an example of an REU Site. Second, the paper pretends to be a guide for others considering either writing a proposal or running one of these demanding programs. It includes the most important aspects that we consider *all* REU programs must have to be successful and the strategies that provided the best results in our case. Finally, the paper focuses on the faculty mentors, a sometimes overlooked and key aspect in these programs. An entire section describing in detail how the mentors were evaluated and what aspects need to be considered to fulfill their expectations is included. The structure of the paper follows exactly the same order.

GENERAL PROGRAM DESCRIPTION

The title of our REU Site is "A Computer Science and Engineering REU Site for Florida, Puerto Rico and Latin America". Compared to other REU Sites, ours is unique in mainly two aspects. First, it is not devoted to a particular theme or topic. Instead, it is fairly open, giving students a broad range of research project options in Computer Science and Engineering. For example, research projects in robotics, computer networks, transportation, computer architecture, data mining, artificial intelligence, and digital image processing were included. The second unique aspect is that, based on the statistics presented above, the authors committed to recruit the majority of the students from the Hispanic minority group, mainly from Florida and Puerto Rico. In addition, the authors also committed to bringing at least one student from a Latin American country each year.

Most of the other aspects of the program are fairly standard. The program was run for 10 weeks during the summer semester, in our case from May 31 to August 5, 2005. Each student was provided with a stipend, travel and housing support, and an allowance for meals. During the 10-week period, students were assigned to faculty mentors to work on the research projects of their choice. In addition, several workshops, presentations and social activities were included in the program. All of this information is available on our Web site at <http://www.csee.usf.edu/REU/>.

MAIN OBJECTIVES

The program seeks to achieve the following main objectives:

- **Increase student involvement from under-represented populations.**
Our primary goal is to involve minorities as much as possible with an emphasis on the Hispanic group.
- **Better prepare undergraduates for their professional careers.**
The students are expected to learn how to use state-of-the-art tools and methods to solve current research and practical problems. It is anticipated that the students will also improve their written and oral communication skills through seminars and formal and informal presentations about their research projects. This REU program is meant to enhance the students' curricular activities to keep them more engaged in their field of study and thus increase graduation rates.
- **Increase recruitment of students in graduate programs.**
Students will be able to work side-by-side with faculty members on interesting and challenging technical problems and realize the importance of graduate education in meeting these challenges. They will also attend presentations describing the advantages of graduate education, the application and admissions process, and the different funding opportunities available.
- **Improve student capability for learning independently.**
Faculty mentors will provide the students with in-depth information and guidance at the beginning of their research assignments. After that initial phase and once given all the tools they need, students are expected and encouraged to work and learn independently.

Our program also seeks to foster the internal REU program at our College of Engineering [8] [Labrador,1], help faculty mentors in their research endeavors, and build stronger ties with minority institutions by helping their students achieve the above stated objectives.

COMPONENTS OF A SUCCESSFUL REU PROGRAM

Running a program like this requires more time, preparation and organization than most people anticipate; it requires careful design and implementation of all of its components. Core components which are critical to the success of the program are described in the following subsections, including several implementation possibilities and the ones that provided the best results for our program.

Recruitment Plan

Recruitment is perhaps the most important program component. A good recruitment plan is necessary in order to guarantee that the program will benefit those for whom it was developed. Recruitment during the first year of a program is especially difficult, since there is not much time between the time the grant is awarded (in our case at the end of January) and the beginning of the 10-week summer program (late May).

Well-known recruitment strategies were utilized in the program. The first strategy was to set up a website and advertise it. Advertising the website can be done in a number of ways. For instance, a flier was designed and put on all bulletin boards around the College. The program was advertised in many of our undergraduate classes and in meetings of technical societies. E-mails and letters (with the flier attached) were sent to all computer science department chairs and many other faculty members in Florida colleges and universities. The URL of the program's website was included in the National Science Foundation list of NSF-funded REU Sites [4]. In addition to advertising the website we also visited the University of Puerto Rico-Mayaguez and held a student recruitment presentation there, including an afternoon-long session to answer questions on an individual basis. The program was also advertised in local minority societies and utilized networking links already in place with other minority organizations, such as the Florida Georgia Louis Stokes Alliance (FGLSAMP) [6] and the College's Office of Recruitment and Retention.

The recruitment efforts yielded a total of 42 applications. Nine applications were received from Puerto Rico, 4 from Latin America and Spain, 13 from Florida, and 16 from outside of Florida. At the end, it can be said that personal contact and the NSF Web site were the most successful recruitment tools. Students were selected on the basis of demographic information, GPA, courses and skills related to the research projects that they chose to work on, career objectives, letters of recommendation and project selection. Finally, six Hispanic students from the University of Puerto Rico-Mayaguez, two Hispanic students from our own College of Engineering, two African-American students (one from Bethune Cookman and one from Florida A&M), two students from the Universidad del Norte in Barranquilla, Colombia, and one student from Universidad de Navarra in Spain, for a total of 13 students were selected and joined the program. It is important to mention that the NSF grant only supported 9 students. One student was supported by FGLSAMP; the students from Colombia were supported by our College of Engineering and the Universidad del Norte; the student from Spain was self-supporting.

Program Evaluation

Program evaluation is another component that should be included in all REU programs. It is necessary to know if the program's objectives are being met. Evaluation is also needed to identify areas of the program that require improvement. Program evaluation can be done either by the PIs or by an entity specialized in program evaluation. The latter option was chosen because it offered a more efficient methodology for collecting and analyzing data and it ensured unbiased results. Specialists from the USF Center for Research, Evaluation, Assessment and Measurement (CREAM) [7] worked in the program evaluation.

In the case of the students, it is important to collect information before, during, and after the program. A survey instrument was designed for each of these time intervals. The first survey mainly collected demographic information and student expectations. Other types of questions were asked to find out about the application process, factors that influenced their decision to join the program, how they found out about the program, etc. The second survey was administered during the program, a weekly evaluation conducted to identify trends in important aspects of the program as well as to detect problems as they occurred. This part of the evaluation was rather short and was implemented in a user-friendly Web application. Students were asked about their day-to-day experiences,

professional development and general thoughts about the REU experience on a weekly basis. The third survey collected information used to evaluate the entire program to determine if the objectives were achieved and if the student expectations were actually met. For example, questions regarding satisfaction with facilities, services, and management, usefulness of the workshops and presentations were asked. This survey also included open-ended questions regarding positive and negative aspects of the program. The final survey will be sent six to eight months after the end of the summer program. In this last survey information about the long-term impact of the program on the students' lives and careers will be collected.

Table 1 is a sample program evaluation guide. It shows the evaluation objectives, the type of questions that need to be answered, the type of data that needs to be collected, and when this data collection process needs to take place.

Table 1. A Program evaluation guide.

Objective	Primary questions	Data source	Stage and students
Assessment of program awareness and recruitment.	How effective are the methods used to advertise the REU program? How successful are recruitment methods in securing diverse students?	Review of recruitment material and procedures; Review of applications received; Demographic data.	Prior to program.
Assessment of expectations.	What are the faculty members' and students' expectations? Were they met? How well the program was organized and delivered?	Survey administered to faculty and students at the beginning and conclusion of the program.	Before and after program to faculty and students.
Assessment of program's objectives.	Did the program increase minority participation? Did the program provide the students with skills and knowledge that they felt could be effectively used in their careers? Have the students improved their capability to learn independently?	Collect information about diversity (topics, cultures, places), communication skills, feelings about Engineering, preparation (tools, techniques, methods), ability to continue learning and doing research independently.	Before, during and after program to students.
Assessment of long-term effects.	Is there evidence that the program has had an impact on students' interests? Did the program increase the enrollment in graduate programs?	Survey questions on frequency and nature of field trips and other extra curricular activities related to Engineering and research; Survey questions on changes in career paths, graduate school attendance, job related information, ability to continue learning and doing research independently, communication skills.	Follow-up survey 6-8 months after program to students.

The results of the entire program evaluation and corresponding recommendations will be included in another publication. However, data processed so far indicates that the program was very successful in achieving its objectives. Survey data and our own experience now indicate that the main aspects described before need to be carefully considered to have a successful program.

Faculty and mentors were also surveyed, however, only two instruments were administered, one pre-program survey and one post-program. The pre-program survey was meant to collect demographic and general information about the mentors as well as their motivation and expectations of the program. The post-program survey was meant to determine if their expectations had been met and to obtain feedback to improve the program for the following year and meet their expectations. Section 5 explains these instruments and their results in more detail as well as elaborates on the most important aspects to consider in order to have good mentors joining the program.

Projects and Professors

Finding faculty mentors and interesting research projects is another important component. This needs to be done at the very beginning so the projects can be advertised. Projects need to be geared to juniors or seniors and designed so that goals can be achieved in a ten-week period. Depending on the number of students, it might be difficult to find the appropriate number of faculty members available during the summer months. Students need a lot of time and attention from their faculty mentors, especially during the first half of the program. A recommended strategy is to have additional projects and faculty mentors available in case some faculty member cannot work over the summer with these students or students want to change their research projects. This strategy proved to be very useful in our case, as one faculty member had to be substituted and two students wanted to pursue different projects after the first week.

This summer students worked on ten different projects either individually or in groups of two. They participated in weekly research meetings with other faculty, students and researchers. More information about the faculty mentors and the projects can be found on the program's web page.

Social and Educational Components

A number of social and educational activities need to be scheduled. These activities are especially important because they help to build a united and coherent group and also provide students with a well rounded education. Social activities may vary from REU Site to REU Site depending on the city in which the program is located and the facilities available nearby. An important factor to consider when planning these activities is that students come from different geographical locations and usually do not have their own transportation. Even though restaurants, movie theaters, a shopping center, and a recreational park were available to students within walking distance or a short bus ride, several other social activities were arranged.

Educational and other informational presentations were also arranged. Workshops on library research techniques, ethics, poster design, presentation skills, writing research papers, getting into graduate school, financial opportunities, patents and licensing, nanotechnology, and strategies for success in professional careers were given. Several of these presentations were organized as lunch seminars. In addition, students were asked to make two presentations to highlight their accomplishments at the middle and the end of the ten-week period. A formal poster competition took place at the end of the program where small cash prizes were awarded. This is a particularly important activity as the students need to practice what they learned during the workshops and their research. Posters need to include all important information in a summarized manner and attract people's attention. Figure 1 shows the poster that won the competition. It is included here as an example to illustrate the most important sections that need to be included in a research poster and how the space is assigned to each one. Since there were other REU programs running at our university this summer, some of these social and educational activities were shared with these other programs and the students from all REU programs were housed in the same dorms.

Administration Time

There are a large number of administrative tasks required to run an REU program such as this one. The organization of the workshops, caterings, poster competition, social activities, payroll and reimbursements, housing arrangements, recruitment activities, program evaluation, use of university facilities and services, receiving and registering applications, selecting the students and sending official acceptance and rejection letters, etc., are only some of the tasks that were performed. The fact that some of the students were foreign students required extra time and effort on our part as PIs. In addition to obtaining a visa, these students needed help to obtain health insurance, open bank accounts, and obtain social security numbers. Finally, there are always questions about the projects and technical meetings (we, the PIs, were mentors as well), and behavioral problems to deal with. In our case, the amount of time needed to perform all these activities was definitely underestimated. However, the wonderful group of students that we worked with made the entire effort worthwhile. The best strategy is to start as early as possible and make a weekly plan of activities.

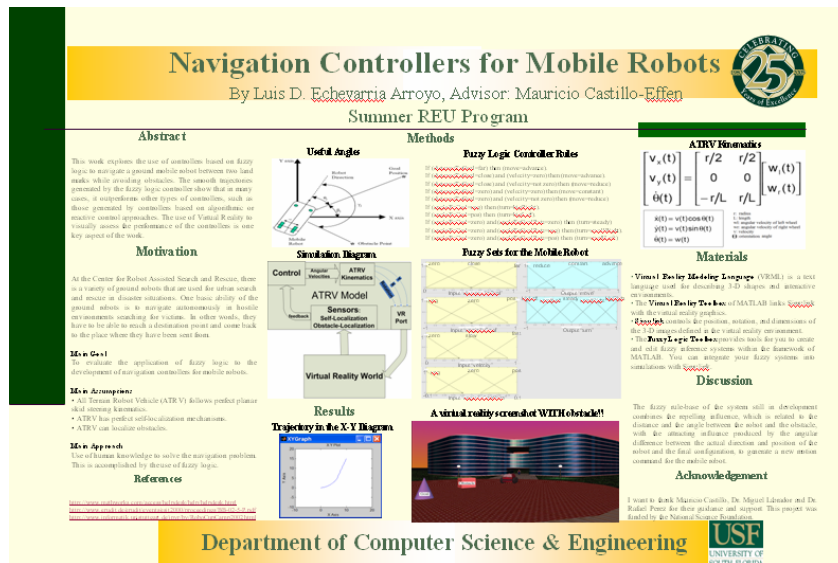


Figure 1. Winning poster in poster competition.

FULFILLING MENTORS' EXPECTATIONS

In addition to describing the most important aspects to run an REU program successfully, this paper focuses on the participating mentors, describing their motivations and expectations from the program and elaborating on the most important aspects to consider so that their expectations are actually met. As mentioned before, two surveys were administered, one before the program and one at the end to gather information about the mentors, their motivations and expectations and their assessment on the impact and value of the program.

Faculty Surveys' Sample Data

In this section, sample data of the participating faculty is presented. Of the eight faculty members participating in the 2005 summer institute, six returned their pre-survey for a 75% return rate. All respondents were male with the majority (n = 5, 83.3%) from the Computer Science and Engineering Department and the other respondent indicating that he worked for The Center for Urban Transportation Research (CUTR), also part of the College of Engineering. Experience teaching at the university level was diverse as was years teaching at USF, with half (n=3) indicating teaching at the university level for more than 20 years and the other half for less (one individual indicated that he had taught at this level for less than five years). Results were similar for total years teaching at USF with only one person indicating a lower experience level at USF at compared to total university teaching experience.

For the post-survey, there was a slightly higher response rate, with eight of nine faculty members (including one advanced graduate student) completing the survey. The demographic characteristics of those taking the post-survey were very similar, as would be expected, to those taking the pre-survey. Again, all respondents were male and the majority was from Computer Science and Engineering. One respondent indicated that he was from The Center for Urban Transportation Research (CUTR).

Based on the demographic data from respondents, the faculty currently involved in the REU program are dominantly male and come from the Computer Science and Engineering Department although experience levels with both overall university level teaching and teaching at USF specifically were quite diverse ranging from one person indicating that he was relatively Junior (less than five years both at USF and teaching at the University level) and another quite Senior (greater than 25 years at USF and teaching at the University level).

Pre-survey Results

The pre-survey was administered the very first day of the program. Faculty members were asked a variety of items about their expectations of the program, the reason(s) they are participating and about any previous experiences with REU or undergraduate students. All respondents indicated that they had worked with undergraduates as part of a research team prior to their REU experience with the summer program. A series of items intended to gather information about what influenced their decision to participate in the summer REU program had some interesting findings (see Table 2). All respondents indicated that they believed “The experience will encourage students to pursue advanced Engineering education” and “The experience will help students become more confident in their skills” influenced their decision *A Lot*. Five of the six respondents (83.3%) chose the same response (*A Lot*) for four of the items (“I enjoy working with undergraduate students”, “I think the experience will help develop better engineers”, “The experience will enrich our college”, and “Students will be able to become more independent”). For the remaining two items (“It is important to support our college” and “Undergraduate students need research opportunities”), four of the respondents chose *A Lot* and two chose *A Little*. None of the respondents indicated that the various factors listed influenced their decision *Not at All*.

Table 2. Responses to “Rate the degree that the following impacted your decision to participate in this summer’s REU program” (n=6)

	Not at All	A Little	A Lot
I enjoy working with undergraduate students	0 (0%)	1 (17%)	5 (83%)
I think the experience will help develop better engineers	0 (0%)	1 (17%)	5 (83%)
The experience will enrich our college	0 (0%)	1 (17%)	5 (83%)
It is important to support our college	0 (0%)	2 (33%)	4 (67%)
Undergraduate student’s need research opportunities	0 (0%)	2 (33%)	4 (67%)
The experience will encourage students to pursue advanced training/education	0 (0%)	0 (0%)	6 (100%)
The experience will help students become more confident in their skills	0 (0%)	0 (0%)	6 (100%)
Students will be able to become more independent	0 (0%)	1 (17%)	5 (83%)

Based on the respondents’ answers to these items, it appears that all of the factors listed did impact, at least to some extent, on their decisions to participate in the program. Factors relating to student’s professional development or faculty’s interest appear to have stronger impact on faculty’s decisions to participate in the program than those more universally applicable to the college or Engineering overall.

The faculty survey also contained three open ended questions: 1) What elements or aspects of the REU program are you most looking for? 2) What elements or aspects of the REU program are you concerned about? and 3) Do you have any other comments or suggestions regarding the REU program at this point in the process? Respondents appeared to be looking forward to both student advancement and products/performance. A couple of the responses seemed to indicate some concern with the students’ abilities to work with the researcher and/or research team fairly efficiently (this is based on the comments about concern with abilities to deal with technical problems as well as the concern about potential work ethic issues). Concern was raised regarding students not receiving their financial support in a timely manner.

Post-survey Results

Faculty were asked to complete a survey at the completion of the REU project. In order to enhance the probability that faculty would be available to respond, the surveys were sent shortly after the fall semester began, approximately four weeks after the completion of the program. Many of the items were parallel to those in the pre-survey with some additional questions added to gather additional information to inform program administrators.

There were 11 items that asked faculty members to rate their agreement using a three point scale (*Not at All*, *A Little*, and *A Lot*) with certain statements about their REU experience. The feedback received on these items was overwhelmingly positive. On four of the items (“I enjoyed working with my undergraduate students(s)”, “I think the experience will help develop better engineers”, “Based on this experience, I am likely to participate in future REU opportunities”, and “I would recommend participating in the program to my colleagues”), all eight respondents selected *A Lot*. For the remaining items, with the exception of one item, seven faculty members chose *A Lot* and one chose *Somewhat*, thus indicating a very positive experience and support for the program from all faculty who responded to the survey. The only item that had slightly mixed results was “The undergraduate students had a positive impact on my research team and project(s)” with five individuals (62%) choosing *A Lot* and three (38%) choosing *Somewhat*. It is notable that there were not any responses of *Not at All* to any of the items.

Evaluation Results

The responses of the six faculty participants on the pre-survey tended to indicate that the faculty involved with the program were motivated to participate in large part by the program’s potential ability to enhance students’ skills and motivation to continue on in their Engineering profession, both by enrolling in graduate studies and learning new skills. The few concerns mentioned tended to focus on logistical issues, including some worries about the students’ abilities to work through problems and have adequate work habits and ethics. However, the results of the post-survey did not indicate that these concerns were founded. Rather, the eight individuals tended to express an overwhelmingly positive experience and a few expressed positive sentiments about their students’ abilities and contributions to their research projects.

Recommendations

The evaluation results just described indicate that the program was fairly successful in fulfilling the expectations of the mentors. In the following, a list of the most important aspects considered in our program that contributed the most to these favorable results is included.

1. **Collected information about the mentor’s projects and requirements as soon as possible and incorporated them in the recruitment process.** This is extremely important. First, the projects can be advertised soon enough so that more students can apply to work on them. Second, once the applications are in, you can clearly identify the candidates that best fulfill the technical requirements.
2. **Established well-defined projects.** It is very important that the proposed research projects are well-defined for undergraduates and realistic in terms of time. At the end of the program you want to show that the students were able to finish their assignments and show a related product. A poorly defined project can result in both student and faculty unhappiness.
3. **Included challenging projects.** Include projects where the students need to learn new tools, algorithms, programming languages, etc.
4. **Incorporated technical requirements derived from the mentors in the application form.** This will allow you to choose the best candidate.
5. **Involved mentors in the final selection process.** Provide mentors with the list of available applicants and the organizing committee’s decision.

6. **Involved faculty in the program as much as possible.** It is important to know their motivations and expectations, so that you can work toward them. Also, it is always a good idea to obtain comments and suggestions, as some mentors have already a lot of experience working in this type of programs. At the end of the program, it is very important to obtain feedback about their experience so that you know whether you met their expectations or not and know what kind of aspects need modification for the following years.
7. **Addressed students concerns and problems during the program.** Make sure the students have all they need to perform the assigned project. This goes from technical aspects such as computers, tools, Internet access, books, etc. to administrative aspects such as access to university services and labs, payroll, social activities, etc. In other words, make sure faculty mentors put their time in mentoring and not in program details.
8. **Included checkpoints and interacted with the students frequently.** Make sure students are making progress in their research endeavors and help mentors in addressing problems if they exist.
9. **Included group building activities.** It is important to include group activities, both social and academic, so that the students get to know each other and help each other. A better team will provide better individual results.
10. **Provided students graduate information.** Faculty mentors are concerned with enrollment in graduate schools and in selecting graduate students for their research endeavors. REU programs are an excellent bridge between undergraduate and graduate school, further, faculty mentors have the opportunity to see the students' potential and recruit them individually. It is important that the program includes some sort of presentation or workshop on graduate studies, application process and financial opportunities.
11. **Provided mentors with some sort of gift or token of appreciation.** At the end of the program, it is a good idea to give mentors a small gift as a sign of appreciation for their time and effort in the mentoring process. This can be something like a good book, a restaurant or book store gift certificate, a small computer gadget that they want, or similar.

SUMMARY

Research Experiences for Undergraduates (REU) programs are an effective vehicle for addressing several important problems in engineering education. For example, under-represented undergraduate minority students can be involved in university research activities with the ultimate goal of ameliorating the trend of under representation of minority students in Science and Engineering. However, these programs must be designed and implemented carefully so that they achieve their objectives. This paper describes our experience running one of these demanding programs and provides guidance on the most important aspects to consider in order to running them successfully. Recruitment, evaluation, projects and professors, social and educational activities, and administration time are identified as the most important components all REU programs must have. Also, the paper presents the view of the faculty mentors describing their motivation and expectations from the program and lists eleven recommendations to fulfill their expectations. These aspects resulted in highly satisfied faculty mentors, increasing the likelihood of their participation in subsequent years.

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