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## **AC 2012-4156: STRATEGIC USE OF SUMMER UNDERGRADUATE RESEARCH EXPERIENCES**

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# Strategic Use of Summer Undergraduate Research Experiences

## Abstract

Participation in undergraduate research before completion of a bachelor's degree provides many benefits for students and faculty. One such benefit is the increased likelihood of pursuing a graduate education. Coordinators of undergraduate research programs play an important role in facilitating this transition by providing resources (e.g. seminars, workshops, speakers) and maintaining communications during and after the research program. Graduate recruiters and faculty have a similarly important role of recruiting these students to their university/program by communicating with students who have participated in summer research at their university and the undergraduates at their university who have participated in summer research elsewhere.

The College of Engineering (COE) at Texas A&M University (TAMU) uses this graduate recruitment model through the Undergraduate Summer Research Grant (USRG) Program. The USRG is modeled after and designed to satisfy the objectives of the National Science Foundation (NSF) Research Experience for Undergraduates (REU); however, funding is provided by the College of Engineering. Not only are domestic undergraduates considered, but also international undergraduates. The USRG is unique in that it serves as an umbrella to other summer research programs within the COE at varying levels such as recruitment, coordination of professional development seminars, and assessments. Summer research programs include the NSF-REUs, NSF-REU supplements, and students funded through their respective departments (e.g. faculty, department heads). Providing an umbrella service relieves departments and REU PIs from the burden of creating (or recreating) an organized program and creates a broader community among students.

We have implemented strategies that have successfully expanded our USRG pool of applicants, diversified institutional representation of applicants, broadened departmental participation, and increased the number of students engaged in research. Thus, the purpose of this paper is threefold. First, we examine the coordination aspect of the USRG and how it successfully serves as an umbrella to other summer research programs such as the REUs. Second, we summarize descriptive and demographic data collected over the past five years on applicants, participants, and alumni. Lastly, we propose a graduate recruitment model for summer research programs to use.

## Introduction

A primary contributing factor in an individual's career advancement is his/her experience. Through experience, an individual gains the necessary knowledge, skills, abilities, and other associated factors to build their resume and move forward in a particular career<sup>1</sup>. Summer research programs at universities are akin to summer internships in industry in that they provide undergraduates the opportunity to gain experience, but in a research and graduate school-simulated setting. Human resource researchers and professionals consider programs like these a type of realistic job preview (RJP). An RJP is a recruitment tool that provides applicants with realistic information about a job in the form of programs, materials, and/or presentation<sup>2</sup>. RJP in the form of programs (e.g., internships) not only benefit the organization in terms of

recruitment, but also the participant. Specifically, summer internship and research programs foster participants' career development by enhancing their ability to identify and make informed decisions about their future career<sup>1,3,4</sup>. Participation in a summer research program has been found to help participants determine their fit in a research setting and whether or not to pursue a graduate degree<sup>4,5</sup>. Higher education institutions should consider incorporating summer research programs as part of their graduate recruitment efforts.

The College of Engineering (COE) at Texas A&M University (TAMU) offers a unique experiential learning opportunity for undergraduates through the Undergraduate Summer Research Grant (USRG) Program. Modeled after the National Science Foundation's Research Experience for Undergraduates (NSF-REU), the USRG program was created as a means to immerse outstanding undergraduates in engineering research. It is hoped that participants gain an appreciation for research by contributing to ongoing faculty research projects or pursuing an independent research topic. More than 555 participants have completed the USRG program since the summer of 2000.

The objectives of the program are to: 1) provide immersive research experience(s) for engineering undergraduates; 2) increase participant's interest in pursuing graduate studies with an emphasis on the Ph.D. program; 3) increase participant's awareness of the graduate school experience; 4) provide an outlet to enhance participant's writing and communications skills; 5) increase participant's understanding of the graduate school application process for admissions and fellowships; and subsequently, 6) position participants to be more competitive for graduate admissions and fellowships. These are achieved through four structural components of the USRG program: 1) the research experience; 2) seminar and workshop series; 3) deliverables; and 4) social activities.

Compared to other summer research programs such as the NSF-REU, the USRG program is unique in several ways. First, it is one of the few programs in the United States that is supported fully by college funds; thus, does not limit status of participants to that of U.S. citizens or permanent residents. Second, faculty and research topics are not limited to a specific research discipline or department within the COE. All 356 faculty members that comprise the 12 COE departments are eligible to participate as mentors. Lastly, the program serves as a logistical umbrella to other summer research programs in the COE.

#### *Summer Research Umbrella*

As previously mentioned, one of the unique characteristics of the USRG program is its "umbrella" role. Not only does it function as an independent research program, but also provides logistical and program coordination support to other summer research programs in the COE. As seen in *Table 1*, the amount of logistical support provided by the USRG program umbrella per student often doubles or triples in size.

Table 1 USRG Umbrella Support of External Programs

Year	USRG Supported Students	Dept. Supported Students	NIH Supported Students	NSF-REU Supplement Supported Students	NSF-Veterans Supported Students	NSF-REU Site Supported Students	Total
2008	41	N/A	N/A	N/A	N/A	47	<b>88</b>
2009	32	6	N/A	N/A	N/A	59	<b>97</b>
2010	31	10	N/A	1	N/A	61	<b>103</b>
2011	38	4	22	1	2	78	<b>145</b>

The USRG program, for instance, shares the pool of applicants with NSF-REU site programs. Likewise, NSF-REU site programs share their pool of applicants with the USRG program. As another example, Principal Investigators (PIs) of NSF-REU programs can elect to have their students participate in none, some, or all of the USRG-coordinated events and assignments. Similarly, PIs of NSF-REU supplemental grants and faculty with individual support can request to incorporate their supplement into the USRG program. That is, the student is selected from the pool of USRG applicants and included in all USRG-coordinated events and assignments, but funded by the NSF-REU supplement. In recent years, some Department Heads provide matching funds for every USRG-select student to their department thereby increasing the pool of participants and potential graduate students.

This model has been successful in relieving PIs from extra administrative work or hiring extra staff to develop and maintain an existing process and program. With an umbrella model in place, the USRG Program Coordinator acts as a subject-matter-expert in the areas of program coordination, scholarship policies, and financial processing to other summer research program staff in the COE. We believe that students also benefit from the umbrella model because it removes the discipline- and program-specific silos, providing them an opportunity to interact with one another.

#### *Administration*

The USRG program is housed in the COE academic dean's office, locally known as Engineering Student Services & Academic Programs (ESSAP). ESSAP is the academic heart of the COE concerned with 1) K-12 outreach, 2) undergraduate recruitment, 3) undergraduate retention, 4) undergraduate advising, 5) undergraduate research and outreach, 6) graduate recruitment, and 7) graduate advising. The office is lead by the Associate Dean for Academic Affairs and is supported by four executive administrators: Assistant Dean for Undergraduate Studies, Assistant Dean for Graduate Studies, Director of Programs, and Senior Manager of Services. The USRG program falls under the purview of the Assistant Dean for Graduate Studies who oversees 5-7 of the aforementioned ESSAP activities. All aspects of the USRG are organized and managed by a Program Coordinator who also provides support in the area of graduate studies. The Program Coordinator is supported by a graduate student who assists with the USRG program.

#### **Program**

##### *Background*

The USRG program is a 10-week residential program for Texas A&M University and non-Texas A&M University undergraduate students. Participation is limited to students who have

completed at least 60 total hours (junior standing) with a minimum cumulative GPA of 3.25. Applicants should plan to graduate no sooner than December after the summer program. Both domestic and international students are eligible to apply; however, only international students currently enrolled at Texas A&M University can apply. The international student restriction is set in place because of the additional steps and paperwork associated with transferring the student from their home university to our university. Participants are restricted from enrolling in coursework for the duration of the summer other than the required research course. This course is graded at the end of the term and appears on the student's transcript. Tuition and fees associated with the course are paid for by the USRG program. Registered students are given full access to university resources such as the computer labs, recreational center (gym), health center, and library databases.

In addition to gaining research experience and knowledge about graduate school, USRG participants receive financial support in the form of a scholarship and housing. Each student receives a \$5,000 scholarship that is disbursed in three payments to ensure they remain active in the program. Payments are made at the beginning, half-way through, and at the conclusion of the program. The scholarship is competitive with the financial support provided to students in other summer research programs across the nation. International student scholarships are subject to federal tax. Participants are given an additional \$1,234 (disbursed in two payments) for living accommodations or have the option to forgo the housing payment and be placed in housing provided by the USRG program. Non-Texas A&M University students are required to stay in the housing provided and are given a maximum of \$500 for travel expenses.

### *Recruitment*

Program recruitment has varied each year, but a concerted effort has been made since 2009 to increase the program's visibility locally and nationally. Marketing occurs throughout the fall semester prior to the start of the program, with the bulk towards the end. Our reasoning behind this approach is the availability of students during the winter break to start the application process. Currently enrolled students at Texas A&M who meet the minimum requirements are informed of the program via an official email from the Associate Dean for Academic Affairs. The email describes the program, eligibility requirements, and directs them to the website for additional information. A copy of the email is then forwarded to engineering undergraduate advisors who are asked to encourage their students to apply for the program. COE faculty are also encouraged to recruit internal and external students. The program is advertised locally to students during special presentations and workshops given by the Assistant Dean and Program Coordinator. During our local recruitment efforts, we also encourage our students to apply for summer research programs at other universities. A website and slide show have been developed to aide in these local recruitment efforts.

State and national marketing for the USRG is aligned with the graduate studies recruitment efforts. Contact information collected from local and national graduate recruitment fairs over the past two calendar years is sorted for program eligibility match. Students who meet the minimum requirements are invited to apply for the program. In addition to these direct recruitment efforts, we also employ passive recruitment activities. For example, our information is posted on the *Institute for Broadening Participation: Pathways to Science* website. The website includes both government-funded and non-government funded programs that serves as a resource for STEM

majors interested in summer research. Students can search for programs based on discipline and geographic location. Another passive recruitment example is our bulk email “blast” to engineering academic administrators at other universities. The list is updated at the start of each academic year and includes the following groups with undergraduate engineering programs: 1) top 25 peer institutions as ranked by U.S. News and World Reports, 2) Texas A&M University system schools, and 3) all Texas universities. Emails are sent to each contact asking that they promote the program to their students.

### *Application and Selection*

Requested application components and the application process mirrors that seen in graduate programs across the nation. In order to be reviewed by the selection committee, applicants must submit a complete application (online form), official university transcripts, two letters of recommendation, and a personal statement. Application components were previously due late February to mid March of each year. This deadline was moved up to early to mid February in order to be competitive with other summer programs including corporate internships. There are slight variations in the application components for local (Texas A&M students) and non-Texas A&M students. Current Texas A&M students are required to have a support letter from the faculty member they intend to work with should they be accepted to the program. The support letter can come in the form of a brief email to the program coordinator or one of the two required recommendation letters. This requirement forces applicants to actively communicate with faculty in advance about their research and summer availability. This self-selection process not only relieves the program staff from matching students with faculty, but increases the likelihood of a positive protégé/mentor relationship. On the other hand, external applicants are highly encouraged, but not required, to identify a faculty mentor in advance. Alternatively, without advanced faculty support, they can list up to three departments for which they wish their application to be considered. If selected to the program, they will be matched with a faculty based on research interests described in the personal statement.

Applications are compiled and sorted on a spreadsheet based on the applicants’ department of interest(s). Reviews and ranking of applicants occur first by a committee at the department level, then another committee at the program/dean’s level. The makeup of department committees varies. The makeup of the program/dean’s committee includes the Associate Dean for Academic Affairs and the Program Coordinator. Applications ranked in the top 75% in each department are then reviewed and re-ranked at the program level. Top-ranked students are then notified of their selection and given an offer that provides additional details about the program and outlines the expectations. The total number of students selected each year is contingent on awarded funding.

After all offers have been accepted, notifications are sent to respective department heads and faculty mentors. During the interim, participants and mentors are encouraged to interact until the official start of the program. Mentors typically give background reading material to familiarize the participant with the research topic.

### **Structural Components: Professional Development**

The success of the USRG program relies on four structural components that serve as professional development opportunities for participants: 1) the research experience, 2) seminar/workshop

series, 3) assignments, and 4) social activities. *Table 2* conveys how each component helps achieve the program objectives.

Table 2 Component Impact on Program Objectives.

Objective	The Research Experience	Seminar/Workshop Series	Assignments	Social Activities
Immersive Research Experience	X		X	
Increase Interested in Graduate Studies	X	X		X
Increase Awareness of Graduate School Experience	X	X	X	X
Enhance Writing and Communications Skills	X		X	X
Increase Understanding of Graduate Admissions and Fellowships Process	X	X		
Increase Competitiveness for Graduate Admissions and Fellowships	X	X	X	

### *The Research Experience*

In terms of learning gains from participation in a research program, those associated with research activities are the most highly rated gains reported by participants<sup>6,7</sup>. That is, students gain more from the research experience itself than any other program activity. With this in mind, the USRG program immerses participants in ongoing faculty or independently developed student research projects for 10 weeks. Whether it is in the lab, field, or library, it is expected that students contribute a majority of the required 40 hours per week to the research. The USRG program is less involved in the research experience as many of the details (e.g. schedule, duties) are organized between the faculty mentor and the student.

### *Seminar/Workshop Series*

In addition to the research experience, USRG participants are expected to attend seminars/workshops offered twice a week. The seminar/workshop series, detailed in *Table 3*, consists of two parts: GRE workshops and seminar series. The first month is devoted to an intense GRE preparatory class. Students accumulate a total of 16 hours of GRE instruction during the month. The course is offered twice a week at 2 hours per day. During the last month of the program, the focus shifts towards a series of seminars where students' awareness about research and graduate school are enhanced. Students are exposed to topics such as the graduate and fellowship application process, research at a national lab, and how to prepare and present a poster. Meals are provided during some of the seminars.

Table 3 Example Seminar/Speaker Series from 2011.

Date	Title
May 31	Welcome Breakfast & Orientation
June 2	GRE Workshop “Revised GRE - What to Expect”
June 7	GRE Workshop “GRE Vocabulary”
June 9	GRE Workshop “Verbal”
June 14	GRE Workshop “Verbal”
June 16	GRE Workshop “Math”
June 21	Luncheon: Faculty Research/Graduate School Advice
June 21	GRE Workshop “Math”
June 23	GRE Workshop “Math”
June 28	GRE Workshop “Written Analytical Section”
June 30	Faculty Research and Graduate School Advice
July 5	Getting into Graduate School
July 7	Federal Funding Opportunities
July 12	The Fellowship Process and Other Funding Opportunities
July 15	Luncheon: Graduate Education and the National Labs
July 19	Abstracts and Research Papers
July 21	Faculty Research and Graduate School Advice
July 26	Effective Poster Presentations
July 28	Faculty Research and Graduate School Advice
August 2	Curriculum Vita and Resume Workshop
August 6	Poster Session and Awards/Closing Ceremony

### *Assignments*

The program strives to mirror the graduate school experience as closely as possible to give participants a realistic preview of their possible future. The required assignments, outlined in *Table 4*, help provide the realistic preview. For instance, we require participants to present a research poster at the conclusion of the program as graduate students often present their research in the form of a poster at discipline-specific research conferences. Additionally, the assignments serve as check points for program administrators to assess the productivity of participants.

Table 4 Example Assignments.

Assignment
GRE Pre-Test
Research Plan and Objectives
GRE Post-Test
Progress Report
Abstract
Research Paper
Research Poster
Poster Presentation



### Social Activities

Formal social activities are currently not organized or required by the USRG program. This is consistent with the <sup>8</sup> finding that students prefer informal social events over formal social events as indicated in the low attendance by the group in their study. However, at the university level, the Office of Honors and Undergraduate Research (HUR) organizes social activities throughout the summer term that are open to any summer research participant to attend. Additionally, HUR compiles a calendar of local community events that students can attend. When USRG administrators are notified of HUR or community events, USRG students are sent an email inviting them to attend.

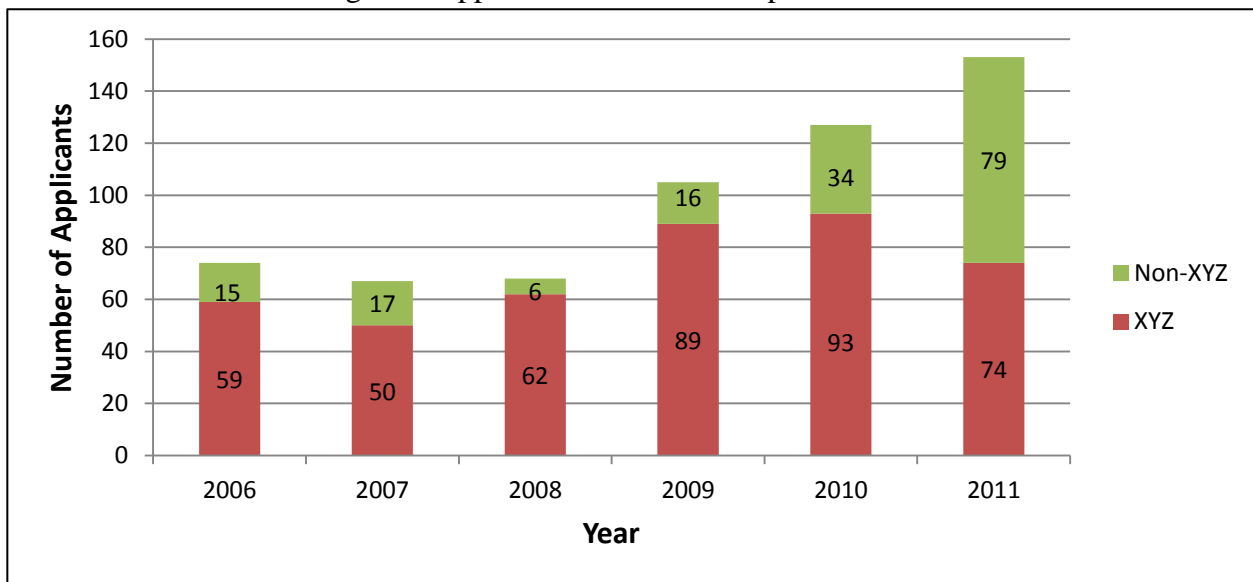
### Historical Data (2006-2011)

The purpose of this section is to analyze the historical trends of the program from the summers of 2006 to through 2011. The results provide a starting point for future program improvement. USRG records from years prior to summer 2006 are incomplete, so those data are not included in this analysis.

### Applicant Trends

As depicted in *Figure 1*, our state and national recruiting efforts implemented for summer 2009 resulted in an increase in the total number of applications as well as the number of applications representing non-Texas A&M institutions. These trends reflect the shift in recruitment efforts focused on non-Texas A&M students. Our goal is not to decrease the pool of Texas A&M applicants, but to increase the pool of non-Texas A&M students.

Figure 1 Applicant Institutional Representation.

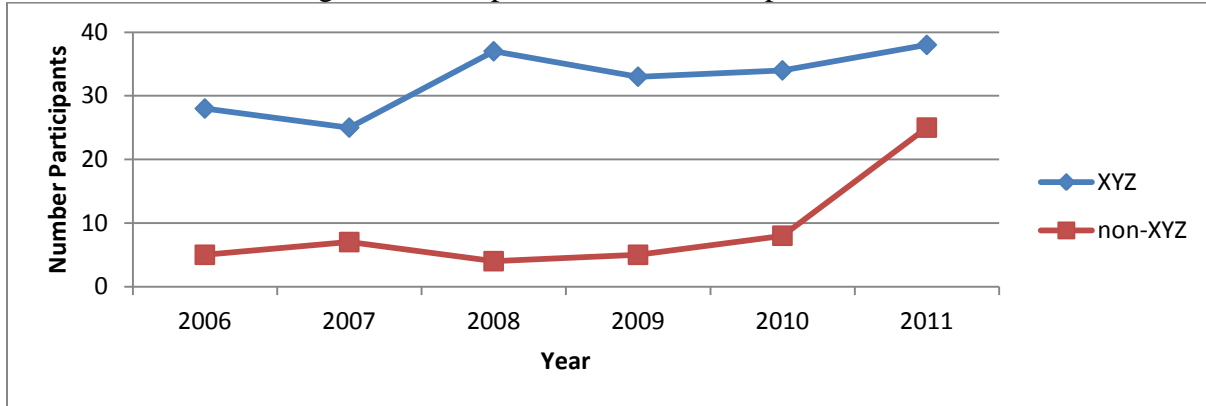


### Participant Trends

From summer 2006 through 2011, a total of 249 students completed the USRG program. *Figure 2* depicts institutional representation of participants during 2006-2011. As seen in this figure, the representation of Texas A&M students remains consistently higher than non-Texas A&M

students, with the exception of 2011. In fact, the average percent of Texas A&M students from 2006-2010 is 84%. It is interesting to note the correlation between institutional representation of applicants and that of participants (compare *Figure 1* and *Figure 2*). At this time, we do not have accurate data on the demographic makeup (e.g. gender, ethnicity, classification) of each cohort, but are currently mining the data.

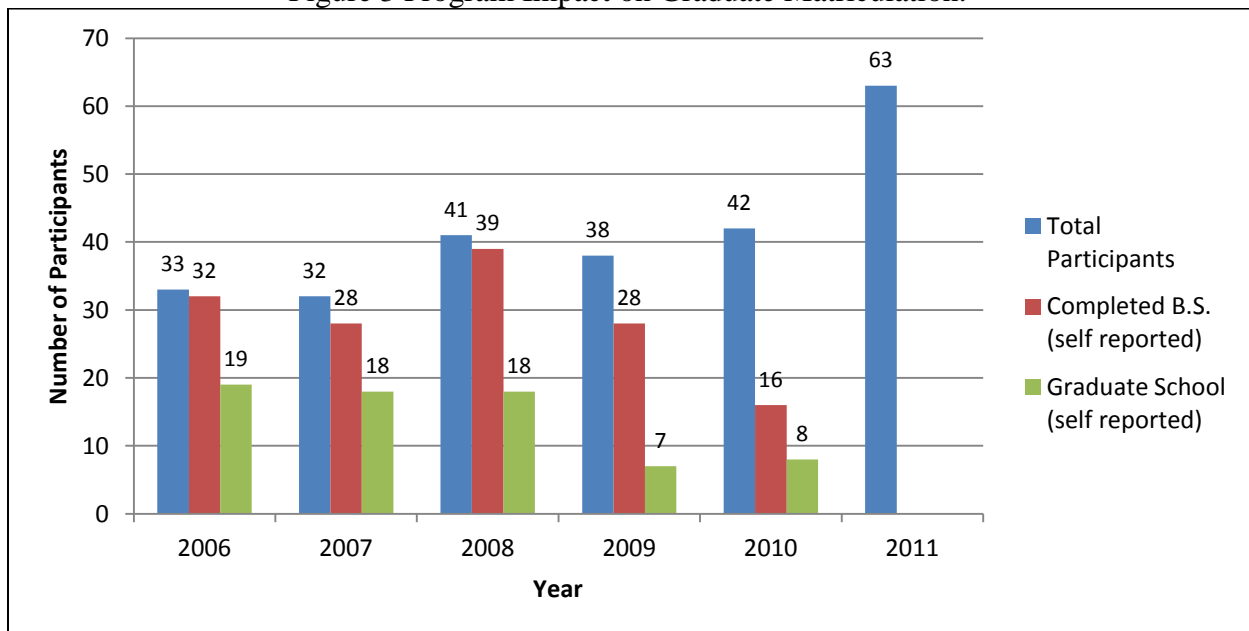
Figure 2 Participants Institutional Representation.



*Post-Program Impact*

A review of post-program trends from 2006-2010 indicates that almost 50% of participants who completed their undergraduate degree matriculate to graduate school (see *Figure 3*). This data is self-reported by the students each year, so the data may not reflect the true number of participants who completed their bachelor's or attended (or are attending) graduate school. Indeed, this is a highly conservative estimate of those who continued their studies. For cohorts from 2009 through 2011, some may still be pursuing undergraduate degrees.

Figure 3 Program Impact on Graduate Matriculation.



A comparison of USRG and College of Engineering NSF-REU post-program trends for years 2008-2010 reveals a 25% higher rate of NSF-REU graduates matriculating to graduate school (see *Table 5*). The higher graduate school matriculation rate among the NSF-REU programs may be due to the smaller size of the cohorts, which allow the NSF-REU programs to establish stronger within-group personal relationships, thereby increasing response rates of the surveys. In addition to being its own research program, the USRG acts as an umbrella to the engineering NSF-REU programs, providing common logistical and program experiences. The NSF-REU data comprises six smaller REU programs each ranging from 8 to 22 participants annually. In contrast, the USRG program on average has 40 participants each year. The program size and spread over the College may impede cohort cohesiveness that results in a lower response rate. The larger cohort expands the opportunities to more students, but individuals may not form as strong ties as in smaller cohorts. Improved tracking and assessments to more accurately quantify students' post-baccalaureate matriculation trends will be implemented.

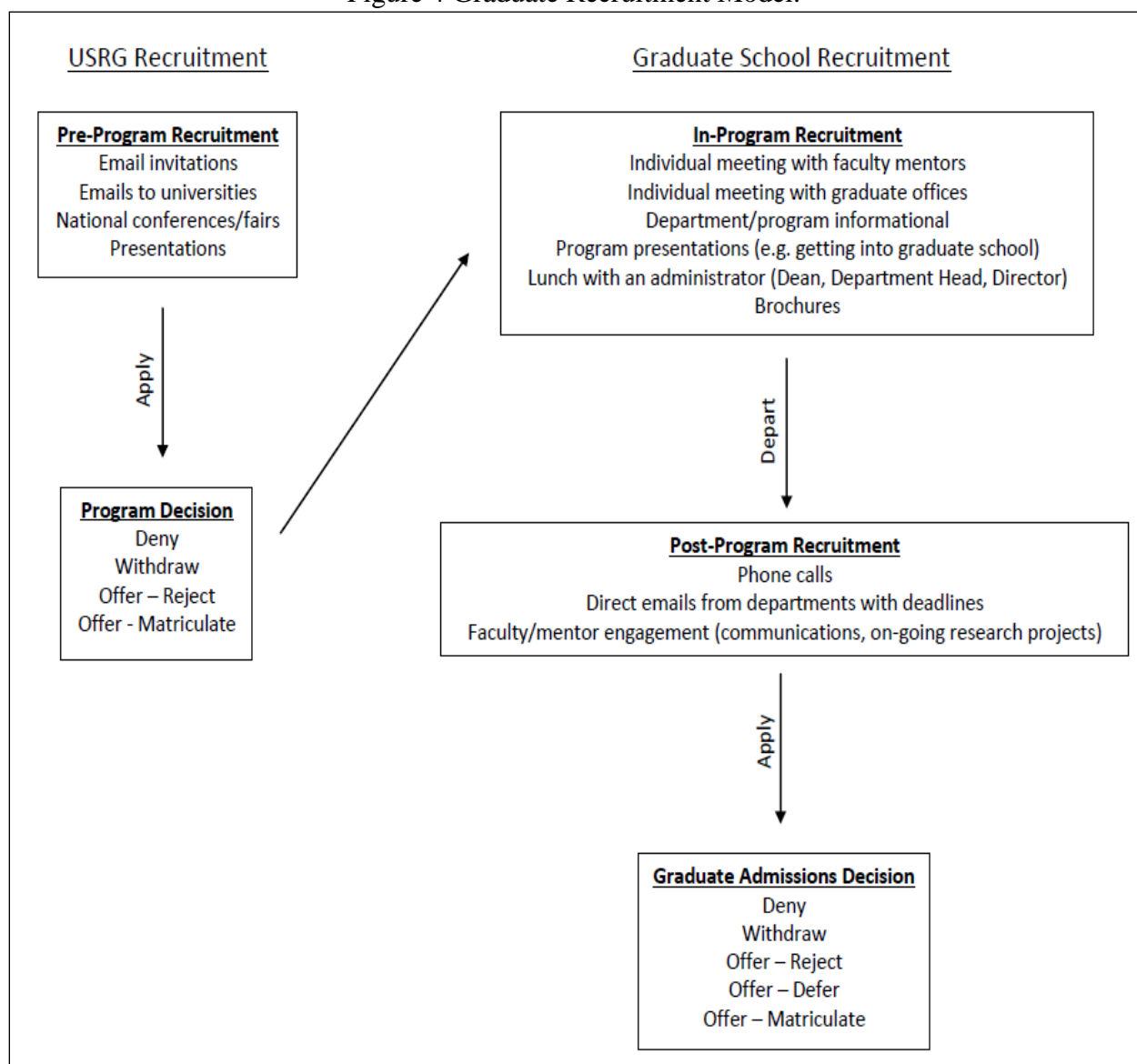
Table 5 USRG and NSF-REU Program Impact Comparison.

<b>Program</b>		<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>Total</b>
USRG	Participants	41	38	42	121
	B.S. Completed	39	28	16	83
	Graduate School Matriculation	18	7	8	33
	% with B.S. Graduate School Matriculation	46%	25%	50%	40%
<b>Program</b>		<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>Total</b>
NSF REU	Participants	47	59	61	167
	B.S. Completed	39	38	25	102
	Graduate School Matriculation	25	24	17	66
	% with B.S. Graduate School Matriculation	64%	63%	68%	65%

### Graduate Recruitment Model

Based on our experience with summer research programs, we believe that participants are an untapped potential for recruitment into graduate programs. Participation in undergraduate research programs is reported to increase the likelihood of pursuing a graduate degree, especially the Ph.D.<sup>4,5</sup>. Many programs hope to achieve this finding, but fail to reach the next step by recruiting them to their respective university. *Figure 4* is a proposed graduate recruitment model suggesting activities to successfully recruit students. This basic model conveys the importance of actively recruiting prospective students through relationships. In fact, the relationship developed with a mentor, be it the faculty and/or graduate student, greatly influences the participant's intention to pursue a Ph.D.<sup>4</sup>. The model is not a panacea for failing programs, but simply an idea to increase and diversify graduate program applicant pools.

Figure 4 Graduate Recruitment Model.



## Conclusion

Undergraduates often are not aware of or do not consider graduate school as an option beyond their bachelor's degree. Participation in a research program provides the realistic job preview discussed earlier by opening the door to research where they can see themselves as a graduate student. In the end, their cumulative experience enhances their competitiveness for graduate admission and funding opportunities. Based on the preliminary analysis presented in this paper, the USRG program has been successful in providing students this experience thereby increasing their competition for graduate school. Our future program goals include identifying additional professional development activities and assignments, incorporating the proposed graduate recruitment model, engaging faculty and graduate student mentors more, especially for graduate recruitment, and making better use of program assessment techniques.

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