Assessing RISE: A Summer Experience for Incoming First Year STEM Students

Paige E. Smith[1], Kristen E. Vogt[2], Janet A. Schmidt[3] and Linda C. Schmidt [4]

Abstract — *Based on available literature on barriers and supports for women's success in science, technology, engineering, and mathematics (STEM), an innovative educational intervention was developed at the University of Maryland. As part of a two-tiered umbrella called Research in Science and Engineering (RISE), the First Year Summer Experience (FYSE) is for incoming first-year women intending to major in engineering, mathematics, and computer and physical science. RISE uses research as the setting to provide students with access to female role models, hands-on learning experiences, and practical knowledge about STEM fields. The program also introduces FYSE students to laboratories and undergraduate students (predominately female) working in the second tier of RISE, a 10-week summer research experience.*

Learning outcomes for FYSE students include a smooth transition to campus and the STEM environment, increased self-confidence, interest, and enthusiasm for a STEM major. Long-range indicators of outcomes are increased persistence in STEM, academic success evidenced by GPA, increased sense of self-efficacy, and subsequent involvement in STEM activities. To determine if these objectives have been met, the FYSE experience has been assessed from multiple perspectives including institutional data, questionnaires, and longitudinal surveys. Results of assessments will be discussed as related to these learning outcomes.

Index Terms — Barriers, First-year Students, Program Assessment, Summer Orientation

INTRODUCTION

Research in Science and Engineering (RISE), the First Year Summer Experience (FYSE) is a two-week residential orientation program for first-year women who are entering the Clark School of Engineering or the College of Computer, Mathematical and Physical Sciences (CMPS) at the University of Maryland, College Park. The program began in summer 2002 and is currently entering the third year of operation. The structure of this program has been described in detail in previous papers [1, 2].

Learning outcomes for incoming FYSE students include a smooth transition to campus and the STEM environment and increased self-confidence, interest, and enthusiasm for a STEM major. Long-range indicators of these outcomes are increased persistence in STEM, academic success evidenced by GPA, increased sense of self-efficacy, and subsequent involvement in STEM programs, including undergraduate research or internship opportunities. An evaluation of our achievement of these objectives is described below. An analysis based on demographics was not included for purposes of confidentially.

INSTITUTIONAL DATA ANALYSIS

Grade point averages were collected each semester from the RISE participants and compared with a control group of female students who began their STEM majors at the same time as RISE participants but who did not participate in the program. Table I provides a summary of the averages with the minimum and maximum grades from each of the semesters the students have been enrolled. The table is subdivided based on students' academic college. Students who changed majors prior to the end of a semester were not included. T-tests for unequal sample size were conducted comparing RISE students with non-RISE students; no statistical differences were found. In 2002, RISE students had slightly higher averages than non-participants. In 2003 RISE engineering students had slightly lower first semester average grades than the engineering non-participants. In CMPS, RISE students had slightly higher first semester average grades compared to non-participants.

Retention information is provided in Table II. For the engineering FYSE students, participation in RISE appeared to improve retention. The picture is less clear for those majoring in CMPS. Note, the numbers reported only account for those students in the original cohorts in engineering and CMPS and does not include data for those who subsequently changed into a STEM major. At times, when students leave CMPS they will transfer into engineering and visa versa; these students are not counted as retained in Table II although they were included as persisters in STEM in the longitudinal discussion that follows.

[1] Paige E. Smith, University of Maryland, College Park, Women in Engineering Program, 1134G Glenn L. Martin Hall, College Park, MD 20742 (301) 405-3931 pesmith@umd.edu
[2] Kristen E. Vogt, University of Maryland, College Park, Women in Engineering Program, 1134F Glenn L. Martin Hall, College Park, MD, 20742 kvogt@umd.edu
[3] Janet A. Schmidt, University of Maryland, College Park, College of Education, College Park, MD 20742 jschmidt@umd.edu
[4] Linda C. Schmidt, University of Maryland, College Park, Department of Mechanical Engineering, 3163 Glenn L. Martin Hall, College Park, MD 20742, lschmidt@eng.umd.edu

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TABLE I
GRADE COMPARISON BETWEEN RISE AND NON-RISE STUDENTS

	2002				2003
	1st Semester	2nd Semester	3rd Semester	Cum.	1st Semester
RISE Engineering					
Mean	3.3888	3.4958	3.4566	3.4714	2.9881
Min	2.7140	2.7690	2.7850	3.0000	1.1250
Max	4.0000	4.0000	4.0000	3.9200	4.0000
Non-RISE Engineering					
Mean	3.2394	3.2798	3.2720	3.3807	3.0700
Min	0.0000	0.0000	1.0000	1.9480	1.3070
Max	4.0000	4.0000	4.0000	4.0000	4.0000
RISE CMPS					
Mean	3.6460	3.5460	3.2415	3.5229	3.0850
Min	3.2660	3.1760	2.3070	2.9500	2.5330
Max	4.0000	4.0000	4.0000	3.8690	4.0000
Non-RISE CMPS					
Mean	2.8670	2.9480	3.2100	not available	2.9470
Min	0.4660	0.0000	0.0000	not available	0.0000
Max	4.0000	4.0000	4.0000	not available	4.0000

TABLE II
RETENTION DATA

		N	1st to 2nd Semester	1st to 3rd Semester
2002				
RISE	Engineering	16	94%	88%
	CMPS	8	50%	50%
Non-RISE	Engineering	72	90%	83%
	CMPS	43	93%	81%
2003				
RISE	Engineering	17	94%	
	CMPS	6	100%	
Non-RISE	Engineering	77	86%	
	CMPS	44	unavailable	

QUESTIONNAIRE ANALYSIS

An end of program questionnaire asked participants several open ended questions including the strengths and weaknesses of the programs, what one aspect of the program they would change, and how RISE influenced their perspective on their major. The response rates for this questionnaire were 100% for both 2002 and 2003 cohorts.

The strengths reported by the participants were similar in both years. The most common response was that the program provided them with a preview of college life, a strong foundation for the fall semester and made them feel comfortable on campus (54% in 2002 and 40% in 2003). The friendships they made with the other women in the program was also a program strength (reported by 63% in 2002 and 36% in 2003). Other strengths included exposure to laboratories, majors, and role models, introduction to resources, meeting the program staff, exposure to a diverse group, and providing an environment where they were comfortable. Example quotes included: “The sense of sisterhood that could be felt. Our group was incredibly dynamic and I think it was due to the fact that there were so many diverse people here” and “RISE allowed me to build a foundation of friendships and education goals for UMD. It's a positive start for a new beginning.”

Similarly participants were asked to list program weaknesses. The responses from 2002 helped to shape the 2003 program. As a result (and happily) the weaknesses were not similar across years. In 2002, participants felt they were over exposed to academic role models (current STEM faculty members) (42%) and that there was not enough free time (23%). They wanted more focus on engineering and science careers through hands-on activities, interactions with women in industry, and less focus on women’s issues in STEM. After 2002, the program was redesigned to integrate more hands on experiences (like a LEGO Team Project and camera dissection) and to enable more interactions with women in the STEM workforce. In 2003, weaknesses included not enough interaction in some sessions (36%), and the desire to learn more about the various STEM academic majors (20%). Like the 2002 program, they felt their time was too rigidly scheduled and by the end of the program they were tired (16%). However the variety of minor frustrations indicated the 2003 program was more successful at meeting the participants’ needs. One telling quote included, “The program was very intense and in some ways it's good but I felt sleep-deprived the whole time and then

during the day I could not pay attention as well as might have liked to, which made some lectures and activities seem very boring."

The participants rated each component of the FYSE program on a scale of 1 (low value) to 5 (high value). Refer to Table III for a summary of the results. The top five activities from 2002 were: 1) Visits to Washington, D.C. and Baltimore; 2) Activities designed to introduce the campus (AJC Online, campus scavenger hunts); 3) Self-defense workshop; 4) Service-learning project, stream clean up; and 5) Team building activities (Kolb learning styles and landmark scavenger hunt). The top five activities in 2003 were: 1) Terrapin Adventure Challenge (ropes course); 2) Advice from academic advisors; 3) Self-defense workshop; 4) Project LEGO; and 5) Tour of the wind tunnel. In both years, the All About Me (personal and social identity) workshop was not highly valued.

TABLE III
PARTICIPANT PERCEPTIONS OF RISE ACTIVITIES

Activity	2002 Mean	2003 Mean
Opening Night Welcome	3.70	4.13
Networking		
Lunch & Learn	3.70	4.48
Reception for Missy Cummings (*Hornet's Nest [3])*	na	3.76
Social with Powerful Women (networking reception)	na	4.32
Visits to DC and Baltimore	4.70	4.40
Social with RISE 2002 students	na	3.29
Graffiti Night	ne	4.64
Negotiating the Campus		
Web Scavenger Hunt	na	3.38
Resources Scavenger Hunt	4.65	3.83
Landmarks on Film	4.04	3.68
Introduction to Campus Programs	ne	3.92
Academic, Personal & Professional Development		
Terrapin Adventure Challenge (ropes course)	na	4.92
Presentation for Closing Celebration	3.91	3.56
Project LEGO™	na	4.84
AJC Online	4.65	4.17
Computer Tear Down	3.65	2.36
MATLAB	na	2.96
Kolb Learning Styles	4.04	3.24
Academic Advisors & Academic Support Panel	ne	4.88
Résumé Workshop/portfolios	2.52	3.92
Physics is Phun	na	3.12
Camera Dissection	na	2.24
Lab Experiences with RISE Research Teams	3.26	3.92
Tours		
NASA Tour	2.26	na
NIST Tour	3.78	na
Wind Tunnel Tour	na	4.72
Observatory Tour	na	3.08
Wilson Bridge Construction Site Tour	na	3.76
Service-Learning (2002: Stream Clean-up, 2003: Inventions with Girl Scouts)	4.04	4.13
Self Defense Workshop	4.65	4.84
All About Me (personal & social identity workshop)	2.39	2.64
RISE Research Symposium	2.39	na

na = not applicable, ne=not evaluated

LONGITUDINAL SURVEY ANALYSIS

Longitudinal follow-up data were collected in February 2004 through an electronic mail survey (three semesters post FYSE for the 2002 cohort and one semester post FYSE for the 2003 cohort). Using items with an open-response format, students were asked to describe their current experiences and involvement on campus and to reflect on their perceptions of the value of the FYSE program. Out of the 24 participants in the 2002 cohort, 15 responded to the survey for a response rate of 63%. The response rate from the 2003 cohort was 60% (out of a possible 25 participants).

The results from the 2002 respondents are divided between students who **persisted** in underrepresented STEM fields and those who **changed their majors**. Most of the respondents were FSYE participants who persisted in STEM. These students were involved in research internships and academic student organizations such as the Society of Women Engineers (SWE) and other professional engineering societies, honors programs and honor societies. Many were also involved in community service, faith-based organizations, intramural sports, social sororities, and other student life activities. Academically, students generally felt their third semester of coursework was difficult but that they learned a great deal. Students noticed the increased demand of their course load and coursework from their first year to their third semester and expected this trend to continue. Although three students were unsure of what they enjoyed most about their major, the other students enjoyed the subject matter most, as they were now taking more major-specific courses. Four students specifically enjoyed the application of course material; for example, knowing that "I will be able to apply my knowledge and skills to protect the lives of others."

The 2002 **persisters** overwhelmingly observed positive benefits from participating in RISE. This appreciation tended to increase over time. One student described the impact quite clearly: "During my first 3 semesters here at Maryland I have had to do some kind of engineering project. In the first group I was the only female and I gained a lot of confidence from RISE about dealing with situations like that. I was not intimidated and learned a lot from the project to help me in engineering." Students consistently cited that RISE helped them feel more confident and comfortable. They felt connected to the institution, to each other, and to the people (students, staff, faculty, and professional role models) they met. They also felt more informed about campus and academic resources and services. One student claimed, "I probably wouldn't have been as involved as I have been. RISE was how I got my foot in the door and the reason for my continuing to volunteer for many of the activities." Another student offered, "RISE has made me understand that everyone is going through the same thing at school. Having close friends in engineering is helpful because I see that I'm not the only one who struggles to understand things and gets stressed about all the work we

have. RISE also made it easier to talk to professors and staff because we became familiar with a lot of them."

Four of the 2002 respondents have **changed their majors** from engineering, computer science, or mathematics to other majors. Academically, two of the four were successful in their STEM major before changing to non-STEM majors (accounting, biochemistry, classics, and architecture). Despite their change of major, these students held positive perceptions of the RISE program and its influence on their college careers; "I think the program was very successful - it helped us transition into the engineering school… and it also gave us some information on the outside world in engineering and the sciences." Three of four have maintained strong contacts with other RISE participants. All four were satisfied and performing well academically in their new majors.

Each of the 2003 respondents to the longitudinal survey were **persisters**. The 2003 respondents reflected on their first semester on campus. Eleven of the 15 students were involved in STEM-related activities, such as SWE and other professional engineering societies; two were involved in a research internship. Seven of the students were involved in other student activities, such as University Orchestra, the Organization of Arab Students, and volunteering at a day care center. Most students reported they enjoyed their classes and applying their learning through course projects. Academic related outcomes were split. Half of the students were disappointed in their grades and coursework. As one student stated, "I thought that I was balancing my work load and my free time but I found out that that was not true and by the time I tried to correct my mistake it was too late." Another student commented on the difference between high school and college stating, "It was weird for me to put forth my all in a class and still come out with a B." The other half of the respondents thought their semester went "really well." Some reported the courses were challenging, they needed to learn the expectations of professors, or they learned to manage their time; overall this half of the respondents enjoyed their classes, earned academic honors, and were satisfied with their grades.

Grades and course experiences were what influenced confidence in the students' STEM abilities. Students cited positive course experiences as boosts to their confidence, especially when they improved over the duration of the semester. An example is one student who stated, "My confidence increased as I went through challenging classes and did good at the end. I had to put a lot of hard work into getting good grades and knowledge, and sometimes it seemed like it was impossible and I wanted to give up, but it turned out well at the end. I now have more confidence I can succeed." Another student commented, "I don't think my confidence has changed per-se, but I do think I am more comfortable with saying and knowing that [my major] is right for me, and that its okay to love the sciences and math!" Alternatively, students' confidence was shaken when they performed poorly in a class. However, all 6 students who described an experience that decreased their confidence also included a positive experience that sustained their confidence and self-esteem.

DISCUSSION: BENEFITS OF MAJOR PROGRAM ELEMENTS

RISE planners purposefully included a number of experiential learning activities for program participants. These activities cover three vital categories: technical skill-building, community building and engineering design. One of the top-rated FYSE activities reported in Table III fell into each category.

Technical Skill Building: Women entering STEM fields often lack experience or confidence in computer and internal network applications compared to their male counterparts [4]. To develop self-efficacy on University of Maryland computer systems, the FYSE program included sessions on AJCOnline (the college of engineering course website), building their own web pages and planning online portfolios. This series of hands-on labs was expanded in the 2003 program to include a web scavenger hunt and an Introduction to MATLAB, a symbolic mathematics problem solving software. RISE participants rated these activities as generally favorable.

Learning Community: Recent results from a longitudinal study of the effects of integrating elements of the first year curriculum at the Colorado School of Mines (CSM) on graduation rates and student satisfaction emphasize the power of learning communities as a tether for students as they navigate their university experience [5]. The study at CSM supports others indicating that "students who feel that they belong from the beginning are more likely to persist, even if the intervention terminates (p. 34)." The FYSE in both 2002 and 2003 enabled participants to create a cohesive learning community that extended into the academic year. Overwhelmingly, the data showed that strong friendships, peer support, and networks of support staff and role models contributed to students' sense of belonging, self-confidence, and successful transition from high school to college STEM majors.

Confidence in Engineering Design: A study of freshmen engineering student attitudes across 17 different institutions revealed gender based differences in self assessment of engineering abilities [6]. At every institution, males rated their engineering ability significantly higher than females. RISE postulates that success experiences can counteract insecurities. The LEGO™ Project experience was introduced in the 2003 FYSE program to create positive experiences on important EC 2000 outcomes like the ability to design a system to meet specifications. Participants worked in teams to design, build, program, and test a LEGO™ mobile robot to maneuver an obstacle course. The students worked on interdisciplinary teams on a project that introduced rudimentary principles in mechanical, civil and electrical engineering disciplines and required a modest

amount of computer programming. RISE participants rated the LEGO™ Project as 4.84 out of a possible high of 5.00 for overall value.

CONCLUSION

The RISE FYSE continues to use participant feedback and assessment outcomes for program improvement. In the first year, the focus of the program was three-fold: introducing the students to the campus and surrounding community, to faculty and upper-level students in the summer research program, and raising awareness of the barriers in STEM fields. In the second year, emphasis shifted so that students were given more opportunities to network with a variety of women in STEM (professionals, faculty, and students), and more hands-on activities (e.g. LEGO™ team project) were included in the schedule. And finally the students were provided with more opportunities to learn about their major through discussions with the dean of engineering, assistant dean in CMPS, advisors in the colleges, and a variety of support staff.

The data collected in multiple formats provided a rich understanding of students' perceptions of the FYSE program, its relationship to their college experience, and learning outcomes achieved by participants. The evidence suggested that FYSE assisted students in their transition to campus and STEM by acclimating them to the university's environment before classes began and by connecting students to a network of peers, role models, and supportive faculty and staff. Students also described their enhanced commitment to STEM, although there was less evidence regarding the attainment of this outcome, and it appeared that an increased interest was not consistently achieved by all students. Long-range indicators of FYSE impact included continued persistence in STEM, academic success, and subsequent involvement in STEM programs, including undergraduate research or internship opportunities. The retention data demonstrated that most students persisted, and that those who did are academically successful. However there was little difference in grades between RISE participants and students in the control groups. Finally, at this point in time, there was some evidence that FYSE participants continued to seek out additional opportunities to participate in STEM related activities of both a social (SWE, outreach activities) and academic nature (research internships).

The results for retention were clearly mixed. However, future research on FYSE will explore if FYSE students are making decisions about their major in a timely manner with more confidence in their decisions. The longitudinal data provided some support for students' confidence in their decision. More targeted questions regarding confidence will be added to future assessments.

The FYSE program continues to evolve based on participant feedback. The program will increasingly be tailored to the majors of the FYSE participants, particularly those in CMPS. Furthermore, more opportunties will be implemented to better connect participants with current undergraduate students in STEM. The FYSE meets the learning outcomes of acclimating students to the University of Maryland and STEM and increasing confidence in a STEM major.

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