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BOARD # 377: Improving Graduation Outcomes in STEM: Preliminary Results from the RISE Scholars S-STEM Program

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Improving Graduation Outcomes in STEM: Preliminary Results from the RISE Scholars S-STEM Program

Introduction

The National Science Foundation's Scholarships in STEM (S-STEM) program funds scholarships and support for the recruitment, persistence, graduation, and placement of academically talented low-income students into STEM careers [1]. Beyond directly supporting individual S-STEM Scholars, the program seeks to identify curricular and co-curricular activities improving STEM persistence and career placement that can be applied more broadly.

The S-STEM funded RISE Scholars Program at Roger Williams University examines the effects of engaging undergraduate students in a structured practice of science communication [2]. Recent studies have shown that instruction in science communication can improve students' sense of identity and self-efficacy within STEM majors [3,4], which in turn are well known to support persistence. This paper presents preliminary results on the academic performance, graduation, and placement of the first two cohorts of RISE Scholars.

RISE Program Overview

The program is funded by a $999,999 Track 2 S-STEM grant [2] and has supported a total of twenty Scholars in three cohorts entering the university in 2019, 2020, and 2021. The Scholars' majors include Engineering (6), Biology (4), Marine Biology (4), Computer Science (3), and Forensic Science (3). Key features of the program include:

- A $10,000 annual scholarship for each Scholar, renewable for up to four years.
- A weeklong residential summer bridge experience intended to develop incoming Scholars' curiosity, introduce them to science communication, familiarize them with campus support resources, and build community within the cohort. Students worked with a local non-profit advocacy organization and university faculty to investigate marine microplastic pollution, met with scientists and toured facilities at Woods Hole Oceanographic Institute, brainstormed solutions using the engineering design process, and presented their findings to campus leaders and invited guests.
- Two courses on Public Speaking and Science Writing. These were customized versions of required general education classes, refined and taught by faculty in those departments to focus specifically on communicating about science and technology. RISE Scholars took the Public Speaking course with their cohort in their sophomore year, and the Science Writing course with their cohort in their junior year.
- A variety of STEM and communication themed co-curricular activities (e.g., a seminar and meeting with a university alumna researching bio-inspired robotics, a workshop on using stories to communicate science by The Story Collider [5], a field trip to biotech company New England Biolabs).
- Workshops on identifying and applying for summer internships and research experiences.

- Stipends and housing for summer research; travel support for conference attendance.
- Dedicated tutors who participate in program meetings and activities. The program is anchored in the university's tutoring center, which is led by two program co-PIs, based on success with that approach on our prior S-STEM program [6].
- Academic advising and mentoring by program PIs or other key personnel.

Assessment Methods

As one of several approaches used to assess the program, this study examines four-year student outcomes including graduation rates, cumulative GPA, and post-graduate career placement. Data on student academic performance and progress, as well as incoming student characteristics and participation in various support programs, were obtained from university records for the first two RISE cohorts, totaling fourteen Scholars, and for a control group of all 287 non-RISE first-year students who entered the university in a STEM major in Fall 2019. These data include:

Student Characteristics:
- High school GPA
- SAT scores
- First math course
- First writing course
- Gender
- Race/ethnicity
- Pell eligibility

Participation in:
- RISE Scholars Program
- Honors Program
- SOAR Program
- Varsity athletics
- On-campus housing
- Tutoring

Student Outcomes:
- 4-year graduation from the university
- 4-year graduation in a STEM major
- 4-year graduation in student's original major
- Cumulative GPA at graduation, exit from the university, or end of fourth year if still enrolled

In addition, the RISE Scholars were surveyed about their career or graduate school placements by the project PIs six months after graduation.

Student's *t*-test was used to compare the mean values of numerical variables such as GPA and SAT scores between the RISE and control groups. Fisher's Exact Test was used to compare binary variables such as 4-year graduation and participation in other programs.

The RISE Scholars significantly outperformed the control group on all outcome measures. To examine whether their superior outcomes can be attributed to participation in the RISE program, and not solely to their academic talent (which is a criterion for any S-STEM recipient), linear and logistic regression were performed to predict final cumulative GPA and four-year graduation in STEM, respectively, while controlling for factors related to student preparation (e.g., high school GPA, math SAT score), identity (gender, race and ethnicity), home environment (on- or off-campus residence), and participation in other support programs. Stepwise regression was used to eliminate weak predictor variables from the models.

Results

Table 1 presents four-year outcome data for the RISE Scholars and the non-RISE control group. All but one RISE Scholar graduated within four years, each in the STEM major they started in.

Table 1: Student Outcomes

	RISE Scholars (n = 14)	Control Group (n = 287)	
Four-Year Graduation Rate			
From the university	92.9%	55.8%	p = .005
In any STEM major	92.9%	42.5%	p = .0002
In original STEM major	92.9%	36.6%	p < .0001
Final GPA (mean ± S.D.)	3.39 ± 0.46	2.87 ± 0.86	p = .025

In contrast, only 56% of the control group graduated in four years (p = .005), 43% in a STEM major (p = .0002), and 37% in their original major (p < .0001). The RISE Scholars' mean GPA at graduation (or completion of fourth year, for one continuing student) was 3.39, compared to a mean GPA of 2.87 for the control group (p = .025).

Table 2 compares the demographics of the RISE Scholars and control groups. The RISE Scholars had significantly higher mean high school GPA, were less likely to start in remedial writing, were more likely to be eligible for a Pell Grant and to identify as Black or Hispanic, and spent more time in the tutoring center. These differences are not unexpected given that RISE Scholars were chosen based on academic talent and financial need, and the program emphasized tutoring.

Table 3 shows the results of the linear regression model for final cumulative GPA (at graduation, exit from university, or the end of continuing students' fourth year). Only significant independent variables are included. The strongest predictors of final GPA are high school GPA and race/ ethnicity, followed by gender, math SAT score, and RISE participation. The model suggests that RISE participation independently accounts for 0.251 points of the difference observed in final GPA between the RISE and control groups (p = .017).

Table 2: Student Characteristics and Participation in Support Programs

	RISE Scholars (n = 14)	Control Group (n = 287)	
High school GPA	3.78 ± 0.24	3.42 ± 0.42	p = .0002
Math SAT	594 ± 41	584 ± 66	p = .65
Reading and Writing SAT	591 ± 81	588 ± 71	p = .85
in Calculus I or above	57.1%	38.3%	p = .17
in Non-remedial writing	100%	70.4%	p = .013
% Women	57.1%	48.8%	p = .59
% Black or Hispanic	71.4%	10.8%	p < .0001
% Pell eligible	78.6%	24.4%	p < .0001
in Honors Program	14.3%	7.0%	p = .27
in SOAR Program	7.1%	0.7%	p = .13
Varsity athlete	7.1%	15.0%	p = .70
On-campus housing 1st year	92.9%	92.7%	p = 1.00
Tutoring (avg. hours/semester)	8.50 ± 6.62	3.17 ± 4.15	p < .0001

Table 3: Linear Regression Model for Final Cumulative GPA[a]

	b	*β*	*t*	*p*
Intercept	-1.366	0	-2.81	.0052
High school GPA	0.860	0.425	8.09	< .0001
Race/ethnicity (1 = Black or Hispanic)	-0.269	-0.216	-4.08	< .0001
Gender (1 = female)	0.151	0.176	3.53	.0005
Math SAT	0.00228	0.158	3.04	.0026
RISE Scholars Program (1 = RISE)	0.251	0.124	2.40	.017
	$R^2 = 0.340$, $R^2_{adj} = 0.329$			

[a] The *b* column indicates the regression coefficients, *β* the standardized regression coefficients, *t* the t-statistic for the coefficients, and *p* the p-value.

Logistic regression was used to model four-year graduation because it is a binary outcome [7]. We focused specifically on graduation in a STEM major because that is a primary goal of the S-STEM program. Table 4 presents the results of a model including only significant or near-significant effects. Controlling for high school GPA, Pell eligibility, and initial math course placement, RISE participants had 13.85 times the odds of graduating in four years in a STEM major as non-participants ($p = .0015$).

Six months after graduation, nine RISE Scholars were employed in a STEM field, three were pursuing graduate degrees in STEM, and one was employed in a non-STEM field.

Discussion and Conclusions

The results indicate that the first two cohorts of RISE Scholars had a mean GPA 0.25 points higher than would be predicted from their high school GPA, math SAT score, gender, and race and ethnicity alone. More strikingly, the logistic regression model showed that RISE participation increased the odds of graduating in a STEM major in four years by nearly 14 times compared with students with identical high school GPA, first college math course, and Pell eligibility. Both these results are substantial and statistically significant. All but one Scholar continued on to employment or graduate study in STEM fields. We conclude that the RISE Scholars Program has been highly effective in promoting student persistence, graduation, and placement into STEM careers.

Table 4: Logistic Regression Model for Four-Year Graduation in a STEM major

	Odds ratio	*95% CI*	*p*
RISE Scholars Program	13.85	2.39-266	.0015
High school GPA	4.49	2.34-8.86	< .0001
Placement into Algebra rather than Calculus	0.262	0.144-0.472	< .0001
Placement into Precalculus rather than Calculus	0.512	0.249-1.04	.064
Pell eligible	1.70	0.925-3.19	.088
		pseudo $R^2 = 0.175$	

Strengths of the study include the use of a large comparison group and the statistical control of key factors known to impact student performance and persistence. Future work includes adding the third cohort of Scholars when they graduate in May 2025 and expanding the control group to include non-RISE students entering in 2020 and 2021. The results are unlikely to change substantially, as the third cohort of RISE Scholars are all on track to graduate in four years in their original STEM majors, with an average GPA of 3.58 after seven semesters.

Additional work is needed to determine which elements of the program contributed most to student success. Like most S-STEM programs, the complete package of student support is resource-intensive; can the observed benefits be obtained for a fraction of the cost? Analysis of transcripts and notes taken by our program evaluator during annual interviews with the Scholars may provide insights on this question.

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