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Using Enhanced Professional Networks to Increase Overall Student Retention

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Dr. Robert M. Stwalley III, P.E. joined the Agricultural & Biological Engineering department as a faculty member in the fall of 2013. He earned his Bachelor of Science in Agriculture and Biological Engineering (ABE) and his M.S.E. and Ph.D. from Mechanical Engineering at Purdue University. Dr. Stwalley is the former Director of Professional Practice at Purdue, has more than 20 years in STEM education, and has been a long-term advocate for improving equity in education. He is a long serving public school board member and President of the Indiana School Board Association. In his current capacity as an ABE professor, Dr. Stwalley works on precision livestock instrumentation to improve animal welfare and performance, increasing potable water access in the developing world through tube well utilization, and equity in access to higher education for low socio-economic status students. Dr. Stwalley developed the Rising Scholars program to help demonstrate that access and support are the most crucial elements of success in higher education for STEM majors.

Dr. Carol S. Stwalley, Purdue University at West Lafayette (COE)

Dr. Carol S. Stwalley, PE joined the Minority Engineering Program team in the fall of 2007 as Recruitment and Retention Analyst. She earned her Bachelor of Science in Agriculture and Biological Engineering (ABE), MSABE, and PhD ABE from Purdue University. Carol has more than 14 years in diversity work with considerable background working with the Women in Engineering Programs at Purdue. In her current capacity as Recruitment and Retention Analyst for the Minority Engineering Program and the Purdue Office of Institutional Assessment, Dr. Stwalley collects, analyzes and manages data pertaining to the outreach, recruitment, retention and graduation of engineering students from historically underrepresented groups.

Ms. Virginia Lynn Booth-Womack, Purdue University at West Lafayette (COE)

Virginia received her B.S. in Industrial Engineering and a B.A. in Psychology while at Purdue University. She is currently the Director of Minority Engineering Programs in the College of Engineering. She assumed the position in 2004 after 18 years of manufacturing experience. Her last assignment was Lean Manufacturing Manager for the for the 3.7L and 4.7L Mack Engine facilities at Chrysler Corporation in Detroit, Michigan. Virginia has applied lean manufacturing concepts to identify and close the achievement gap between under-represented minority engineering students and the total engineering cohort. This was achieved focusing on first semester performance and first year retention through implementation of an aggressive transition program targeting first year engineering students from historically under-represented groups. She recently was called upon to serve as interim Executive Director for the National Society of Black Engineers from December 2013 through August 2014 during which time the organization experienced membership growth and strong metric focus towards goal attainment.

Ms. Grace Lynn Baldwin, Purdue University at West Lafayette

Grace Baldwin, joined the Rising Scholar NSF S-STEM program in the Summer of 2017 as a Graduate Research Assistant. She completed her Bachelor of Science degree at Purdue University in Agricultural and Biological Engineering (ABE) with a focus in Environment and Natural Resources Engineering. She has worked with the Rising Scholars' Program during the completion of her Master of Science in Agricultural and Biological Engineering and into her current Ph.D. program at Purdue University also in ABE. As part of the Rising Scholars' program, she has helped plan and organize the student recruitment events, align students with summer research experiences and faculty mentors, and conduct student interviews for program analysis and evaluation. Ms. Baldwin has actively contributed to the collection and analysis of data for the Rising Scholars program, as well as the dissemination of information about the progress of the program.

Sarah LaRose, Purdue University at West Lafayette

Dr. Sarah E. LaRose joined the Department of Agricultural Sciences Education and Communication at Purdue University in the fall of 2018 as an Assistant Professor of Agricultural Education. She earned a Bachelor of Science in Animal Science and a Master of Arts in Curriculum and Instruction from the University of Connecticut, and her Ph.D. in Agricultural Education and Communication from the University of Florida. Dr. LaRose has over 13 years of experience in agricultural education in secondary and postsecondary settings. Since joining the faculty at Purdue, Dr. LaRose serves as a teacher educator, preparing future agricultural educators to meet the needs of a diverse array of learners in their classes. She teaches coursework in curriculum design, laboratory teaching practices, and teaching methods in agricultural education. Central to all of Dr. LaRose's work as an educator and a scholar is an effort to address inequities in agricultural education curriculum, program design, and recruitment practices.

Using Enhanced Professional Networks to Increase Overall Student Retention

Abstract

The National Science Foundation awarded funds in 2016 through the Division of Undergraduate Engineering in an S-STEM program to investigate a connection between student support networks and success within STEM fields in higher education. A Web of Support characterization model, based upon work with indigenous populations, was modified using these 'network' predictors of success for discrimination at the collegiate matriculation point. Promising students with low socio-economic status that successfully passed screening by the modified admissions process were then interviewed by a committee of academic professionals. If selected for participation in the Rising Scholars program, students were provided with an annual $6,500 four-year scholarship. Students had to agree to follow the program guidelines and provide data to the researchers. The Rising Scholars program was designed to be a 'high-touch' path through the undergraduate academic world that incorporated several known best practices in higher education. Incoming Rising Scholar students were matched with students receiving both direct engineering admits and exploratory studies admits that had similar background and academic indicators that matched the Rising Scholar's profile. First year retention for students in engineering and the Rising Scholars program was significantly better than for exploratory studies. Those trends remained in the second-year data. Rising Scholars have significantly better GPAs moving into their second year, compared to both engineers and exploratory studies students. The significance in GPA over engineering students continues into the second year. These positive results indicate that it would likely be advantageous to transition this program to a multi-university project to more effectively demonstrate the robustness of the process for Rising Scholar students.

I. Background and structure of the Rising Scholars Program

The project, NSF S-STEM 1644143: *Rising Scholars: Web of Support used as an Indicator of Success in Engineering*, is a research/scholarship program that was initiated in September 2016 at Purdue University. The research portion of the program was designed to determine whether having a strong support network could outweigh high school grades and test scores in predicting success in STEM majors, particularly engineering. 'Rising Scholars' (RS) is the accepted term for students seeking higher education from low socio-economic status [1] [2]. The scholarship portion of the program was designed to offset about 50% of collegiate costs and be comparable to other merit scholarships at the university.

Research at Purdue University had been performed by the Minority Engineering Program (MEP) to see incoming metrics of students who entered college in another major besides engineering [3]. Many of these students had tried to begin in engineering, but had been accepted into another major, because of concerns with their test scores and high school grades. This study consisted of five years of incoming students (n=50) and showed that the under-represented student did not necessarily need the high incoming test and GPA to be successful. This group had an 80% graduation rate in engineering and a 95% rate from the university. This is compared to a rate of 61% in engineering and 79% from the university for those students entering engineering directly during that timeframe. Comparing incoming metrics, the group starting in other colleges besides engineering had a high school GPA average of 3.16 and 1121 for SAT(CR/M), while those originally admitted to engineering had a high school GPA average of 3.62 and 1272 for the SAT(CR/M).

The question arises as to what other influences might be helping these students out-perform what was predicted when they applied to the university. The research team used a mentoring model based on work by Mr. Derek Peterson of the Institute for Community & Adolescent Resiliency – Unifying Solutions to develop a quantifiable support asset metric for a successful student. Peterson's model is based on the 'Rule of Five' support web, which proposes that more than any other predictor, students with a foundation of five people that can actively discuss and encourage a student to do well in school, will do well in school. Peterson's system was originally used to improve student achievement within Native Alaskan elementary and secondary school districts with high dropout and suicide rates, but he has helped implement it with positive effect throughout the United States, Canada, Europe, and Africa under a variety of circumstances [4] [5]. The team also created a structured path through college that incorporated several positive factors of success identified by the Gallup Index [6]. The RS program worked to create a nurturing and supportive environment for the students, similar to that provided by smaller engineering departments. The authors discuss the academic culture in Agricultural & Biological Engineering (ABE) and how it was a useful model when crafting a program for low-SES students [7]. All students were initially enrolled in the Exploratory Studies (ES) program, whose aim is to help students determine a major that suits their career goals. The students then can work toward their goal with necessary classes before they are able to move into the desired major.

The RS structured pathway through the institution began the summer prior to the students' first fall classes. All of the RS took advantage of the MEP Engineering Academic Boot Camp (EABC). This program is a five-week simulation of the freshman engineering courses of: calculus, chemistry, and English, with a camp-long project of building an electric go-kart. The EABC allows students to see how much work is needed to get good grades in college, compared with their high school classes. The EABC creates a collaborative community of engineering students, develops study and test taking skills, as well as forming a learning community for their first semester at the university. Following the freshman year, the Rising Scholars each obtain a summer research position with the Louis Stokes Alliance for Minority Participation (LSAMP) program. The LSAMP research allows them to see into the laboratories used within their major of choice.

The following year, students continue their research experiences with the Multi-disciplinary Engineering Research Fellowship (MERF), but they take an active role in deciding the scope of the project. The MERF exercise is designed to help prepare them for their senior capstone experience by exposing them to project management activities [8] [9]. The summer following their junior year, the students find an internship. The work experience is designed to aid the RS students in their entry-level professional job searches by providing work experience in their chosen field. Practical work experience within a chosen professional field has been demonstrated to improve collegiate graduates' entry-level starting salaries, level of initial position, and job responsibilities [10] [11] [12]. The authors discuss the importance of experiential experiences in the formation of professionalism in RS students [13]. To establish a reflective element within each RS student experience, each fall the students come together for a one-hour seminar to talk and write about their journey and to continue learning about methods of growing their support web with university professors and staff [14].

The RS students selected for this program implementation were typically residential applicants of a low-socioeconomic status (SES) and that selected an under-represented minority

race/ethnicity in their database entry. There was a three-level process to select these individuals. Initially, students who were moved out of engineering were examined to consider the lower GPA and test scores that were seen in the five-year study. The Common Application (CA) was used during those years, and the MEP data analyst was able to view the applicant's total submission. High school GPA were evaluated down to a 3.0 and SAT(CR/M) to a 1000. Taking two courses among AP Calculus, Physics, or Chemistry had also been found to be an indicator of success, so the group looked at the applicants having taken two of these three courses.

Possible RS were contacted, and a short description of the program was provided. Interested students supplied a written application that allowed the selection committee to estimate a determination metric based upon Duckworth's 12 Grit Index [15], establish the applicant's number of support individuals, and review an essay about how the student had used one of these individuals to reach a goal that others had doubted they could complete. The final selection occurred when the students visited the university, met other students, attended a class, and were interviewed by the selection committee. The selection committee was provided with the student's transcript, essays from the CA, and the RS written application. It was initially hoped that 10 students in each of two years could be recruited for the program, but it actually required three years to recruit 21 Rising Scholars.

II. Results of the Rising Scholar selection process

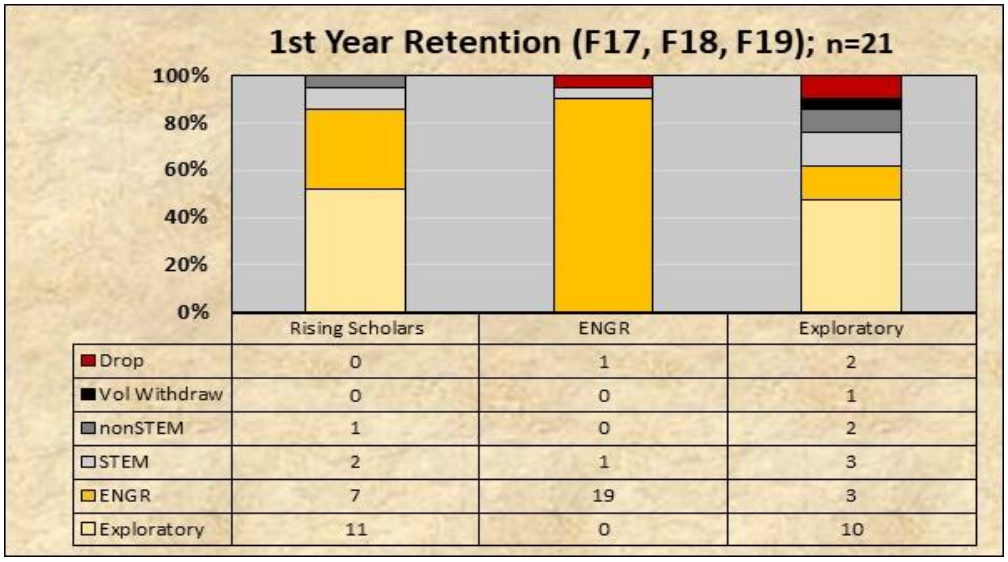
The final demographics make-up of the 21 members of the Rising Scholars program cohorts were:

Gender: 9 - female and 12 - male;
Residency: 18 - residential and 3 - non-residential;
Ethnicity: 14 - Hispanic (1 with American Indian identity);
Race: 3 - Black or African-American;
4 - two or more race (3 with Black identity and 1 with American Indian identity);
First Generation: 11 - students; and
Support Individuals: 6.2 – average number for each student coming into the program.

The initial success of the RS program has been determined by comparing college performance and retention/graduation to other similar students. A one-to-one analysis was created to compare each RS with a direct-admit engineering student and a student that had been moved into another major, Exploratory Studies (ES), during the university application process. Matched students were selected using test scores, high school metrics, original desired major, and first semester courses. Cumulative GPA, credit earned, and retention were the output variables compared between the groups each semester.

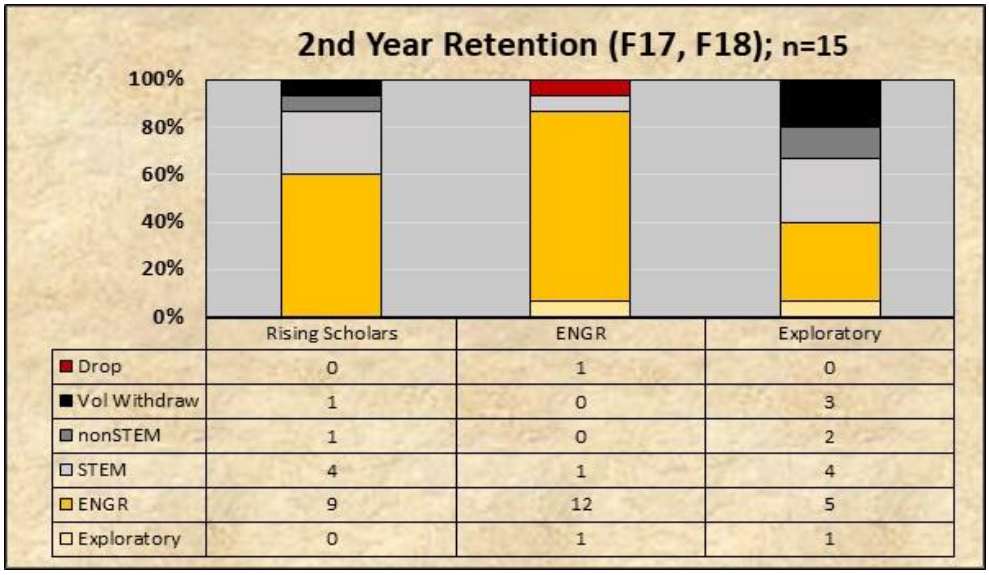
The first-year retention data for all three incoming years (n=21) are included in figure 1. Of note, none of the RS had been dropped after their first year. The Engineering (ENGR) and Exploratory Studies (ES) groups had one and two students dropped, respectively. The number of students remaining in Exploratory Studies were approximately equal between the RS with their peers in ES. The number of RS who had moved into engineering was over double the number of students making that move from the ES group. A Chi-squared test was used to compare the RS against the

ES students who were retained in Engineering majors for a metric which counted all students who remained in exploratory or had moved into an engineering degree. This value was 18 for the RS and 13 for the ES. This comparison showed the RS students were retained at a statistically higher rate than the ES students ($X^2(1)=3.079$, $p=0.040$). Second-year retention could be compared between the first two cohorts of students (n=15). These data are shown in figure 2. No RS has been dropped, and the RS students were again ahead of their ES peers in moving into engineering majors. An engineering match student has been dropped and has not returned to the university. There was no statistical significance found between groups for the second-year retention metrics.



	Rising Scholars	ENGR	Exploratory
Drop	0	1	2
Vol Withdraw	0	0	1
nonSTEM	1	0	2
STEM	2	1	3
ENGR	7	19	3
Exploratory	11	0	10

Figure 1 - First Year Retention between Rising Scholars and matched students starting in Engineering and Exploratory Studies.



	Rising Scholars	ENGR	Exploratory
Drop	0	1	0
Vol Withdraw	1	0	3
nonSTEM	1	0	2
STEM	4	1	4
ENGR	9	12	5
Exploratory	0	1	1

Figure 2 - Second-year retention comparison between the Fall 2017 and 2018 cohorts of Rising Scholars, Engineering, and Exploratory students.

The cumulative GPA at the end of each year was compared between the same groups in table 1. The RS students had a statistically significant better cumulative GPA, above both their Engineering and Exploratory peers for the first-year comparison (RS:E, $t(40)=2.306$, $p=0.013$; RS:ES, $t(40)=2.052$, $p=0.024$). The second year Cumulative GPA comparison resulted in the RS showing statistical significance over the matching engineering cohort (RS:E, $t(28)=2.430$, $p=0.011$). There are not enough cases to statistically compare third year grades. Table 2 presents cumulative credits earned at the end of each year. Little difference is seen between groups, since the university works very hard for students to earn 30 hours of credit each year. These values also count the credit that the student brought into the university from AP, online, and transfer credit course sources.

Table 1 - Cumulative Grade Point Averages earned at the end of each year compared between the Rising Scholars, Engineering, and Exploratory students.

		1st Year (n = 21)	2nd Year (n=15)	3rd Year (n = 6)
F17	Rising Scholar	3.21	3.25	3.26
	Engineering	2.96	2.82	2.94
	Exploratory	2.94	2.94	3.10
F18	Rising Scholar	2.80	2.88	
	Engineering	2.57	2.62	
	Exploratory	2.51	2.59	
F19	Rising Scholar	3.33		
	Engineering	2.48		
	Exploratory	2.75		
AVERAGE	Rising Scholar	3.07	3.03	3.26
	Engineering	2.66	2.70	2.94
	Exploratory	2.70	2.73	3.10

Table 2 - Cumulative Credits earned at the end of each year compared between the Rising Scholars, Engineering, and Exploratory students.

		1st Year (n = 21)	2nd Year (n=15)	3rd Year (n = 6)
F17	Rising Scholar	47	81	113
	Engineering	51	84	115
	Exploratory	47	81	111
F18	Rising Scholar	45	74	
	Engineering	38	66	
	Exploratory	35	59	
F19	Rising Scholar	37		
	Engineering	32		
	Exploratory	40		
AVERAGE	Rising Scholar	44	77	113
	Engineering	40	73	115
	Exploratory	40	68	111

III. Closure

The RS group have shown encouraging retention and performance data when compared against students who entered directly into the College of Engineering. This would seem to suggest that there are other predictive success metrics for college admissions decisions that can better illustrate potential success for low-socioeconomic applicants than test scores and high school GPA. The RS, engineering direct-admit, and ES students will continue to be compared through a six-year graduation cutoff.

It was found that the two out of three approved AP courses created a significant barrier for some students, particularly Black or African American, to be considered for the RS program. This requirement was relaxed and replaced by an applicant's enrollment in the Project Lead the Way, NSBE Junior, summer internships at STEM schools or industry, and/or significant summer workshop attendance being used to replace an AP course enrollment. Another original requirement, that the student was residential, was also relaxed in the second and third years. The RS program was originally designed to help equalize the enrollment disadvantage for in-state low-SES college-bound students considering entry into a Land Grant University. This criterion modification was within the spirit of the program's vision. In-state enrollment of working-class students has its origin in the Morrell Act and is similar to the goal of the RS program. In the end, three out-of-state students who found the program through their own research and initiative were admitted to fill a full cadre of 20 students. This group will be a subset which will permit antidotal results to be reported. Initial results for the Rising Scholar program seem positive. Data collection on the student cadres is continuing, and statistical evaluation is ongoing.

IV. Acknowledgements

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