Board 377: Rising Scholars Graduation Rates and Project Closure Data

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Rising Scholars Graduation Rates and Project Closure Data

Abstract

The Rising Scholars program was established by the National Science Foundation to promote the matriculation and retention of qualified low socio-economic students into STEM fields through the cultivation of their mentor support networks. Rising Scholars students were provided with a scholarship and had a defined path of activities in college designed to enhance their professional mentoring network. They were prearranged to participate in a pre-freshman academic bootcamp, an on-going faculty-directed research project, a self-directed research project, and an internship. Students attended seminars and produced written reflections of their various individual experiences on the path to a professional career. Three cadres of 21 students total, who had expressed a previous interest in engineering, were admitted to a general studies program and provided intensive guidance and an active social group. The Rising Scholars students were successful overall at remaining in a STEM discipline, but their path through college also intersected with the COVID pandemic. These results indicated that strongly supported students faired the social disruption better than their less well supported colleagues. Academic results for the Rising Scholars students against their matched pair grouping for graduation rate and GPA will be presented. Several students interviewed after graduation all professed that they believe they would not have graduated from Purdue and probably would not have attended in the first place. In turn, they would not have their current positions without the Rising Scholars Program.

Keywords

graduation rate; low socio-economic status; professional mentors; STEM disciplines, support networks

Introduction

In principle, the policies of the United States federal and various state governments have always supported educating the population through a meritocracy [1], [2]. Upward mobility in US culture is held-out as a promise to all citizens, but the practical barriers for low socio-economic status (SES) students are significant [3], [4]. Status as a first generation to college or a racial or ethnic minority compounds the difficulties faced by these low SES students [5], [6]. None-the-less, a significant enough number of these unlikely students manage to succeed in attaining collegiate STEM degrees that as a group, they have been christened “Rising Scholars” [7], [8].

In 2016, the National Science Foundation (NSF) sponsored a study by researchers at Purdue University investigating the role of mentor support networks in prompting the success of the Rising Scholars (RS) students. A program was designed to provide partial scholarships to students, lessening the financial burden and concern for families [9], [10], as well as introducing the students to potential professional mentors through association in various activities on campus and increasing their contacts with potential professional mentors [11], [12]. Previous work on the Purdue campus had indicated that students holding a more intimate connection to the personnel and on-going work on campus felt more positive about their collegiate experiences [13]. Students

were selected for participation in the RS program by their preparation, their understanding of the power of mentorship and persistence, and their financial need. Seminars and social functions were provided for the students, and they were given guided opportunities to reflect upon their experiences and improve their future performance [14], [15]. The program attempted to provide collegiate guidance to students with little or no family background in the world of higher education.

The entire program was intended to take advantage of the RS students pre-existing talents, utilize already operational campus programs, and provide several active learning opportunities that are demonstrated to stimulate retention and persistence [16], [17]. Twenty-one students across three entrance years to college were selected for participation in the RS program. These were students who initially expressed a desire to study engineering, but were only admitted into the Exploratory Studies Program at the institution. Their projected 4-year progression through the university is shown in Figure 1. To run a comparison against direct admit engineering students and Exploratory Studies students who did not take part in the program, there were two matched pair groups of students with similar characteristics identified for comparison. The RS students were contrasted against students with as similar backgrounds, demographics, and other characteristics, who were admitted into engineering, as well as similar students admitted into Exploratory Studies. Retention and grade index data for these three groups of students were evaluated as they moved through their college careers and graduated from the institution. This paper will provide a detailed description of the program and its activities, review the past milestones achieved by the RS students, and present the current data on graduation rate for the students. Conclusions about the program and elements which influenced and impeded graduation will be discussed.

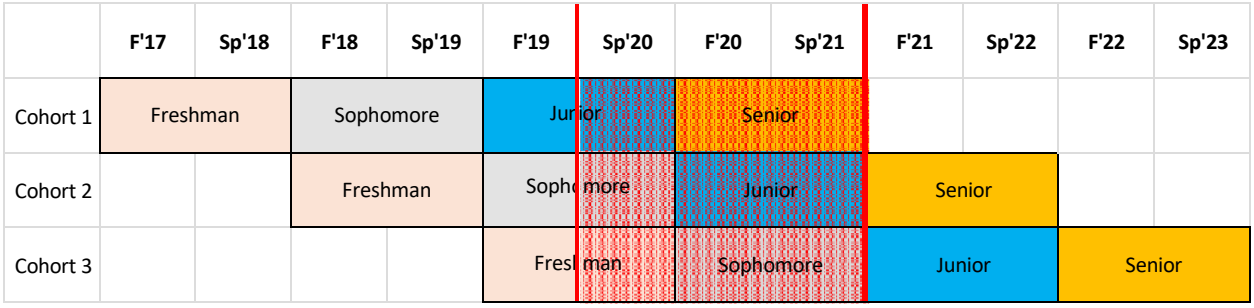


Figure 1- Expected normal timeline of the Rising Scholars program students' progression through higher education, with COVID pandemic cross-hatched between the red lines.

Program Overview

The Rising Scholars Program admissions process has been previously detailed [18]. In summary, students initially seeking an engineering degree and denied admission into the pre-engineering program, were given a chance to work closely with university mentors, gain professional experience and confidence, and still chart a course into a STEM-based profession. Experience within Purdue University advocacy groups suggested a remarkable resilience of minority students with incoming academic metrics lower than those recommended [19]. Lower sufficient metrics for RS selection were established, which included a reduced minimum GPA and the successful completion of an AP course or major extra-curricular project. Reliance upon standard test scores was reduced, as has been recommended and successfully tested in higher

education [20], [21]. Perseverance and grit were evaluated as potential success precursors [22], and the determination of financial need was made by the Division of Financial Aid, according to federal guidelines. These criteria were applied to a small potential recruitment pool of students from exploratory studies for each fall. Unfortunately, the university admissions procedures changed for each year that the RS program was recruiting, which made filling the planned RS cohorts extremely challenging. Three recruiting years (2017-2019), instead of the originally planned two, were needed to enlist enough students for the study, in cadres of six, nine, and six, respectively.

Within the design of the overall program, the researchers sought to include multiple climate-based features, common in smaller engineering departments and advocacy organizations [23]. To promote intra-group socialization, students were invited to in-home celebratory dinners with faculty members, social functions on and off-campus, and seminars with the primary researchers. Significant effort was invested in esteem-building for the RS, by providing a welcoming community for them and demonstrating that faculty and staff members cared about their success [13], [24]. The researchers attempted to maintain a high-touch relationship with the RS students, in order to be available for counseling and advice when needed and to make-up for the lack of familial experience.

A “best path” through the institution, illustrated in Figure 2 [25], was defined for RS students to maximize their experiential activity and contacts with potential professional mentors, thereby enhancing their marketability with STEM field employers and easing their transition into the professional working world [26], [27]. Where possible, existing institutional programs that were already smoothly operating and had common learning objectives that fulfilled the RS program’s goals were recommended for the RS students’ participation, instead of trying to establish a new RS-only activity. Prior to the fall of their freshman year, RS students were sent to the well-regarded Minority Engineering Academic Boot Camp to get a flavor of the intensity of collegiate courses and the step-function of increased effort required to succeed in a STEM-based discipline [28], [29]. Students were introduced to other non-RS perspective engineering students and exposed to the support mechanisms offered by the Minority Engineering Program (MEP). Students continued their exposure to the resources of the MEP by attending a freshman seminar conducted by the MEP Director.

The researchers attempted to involve students in several experiential activities, where the potential impact of the on-going work was evident [30]. It is well-accepted that the current generation of college students have an affinity for environmental and social issues and that linking efforts to these “Grand Challenges” is inspirational and provides an external motivation for long-term career goals [31], [32]. The Louis Stokes Alliance for Minority Participation (LSAMP) program was used to give the RS students their first experience working in a modern research laboratory as a team member under faculty direction [33]. Once the students had experienced working under a faculty member, they were given a chance to direct a project of their own choosing. Similar to a capstone experience, self-directed technical work builds confidence and marketable professional skills during the execution of the project, providing a relatively consequence-free environment for the student to fail and learn, without career-ending ramifications [34], [35]. All students should get this opportunity, but for the RS students, this experience had the potential to be formative by demonstrating that they had the skills to direct

significant technical work and that they could absolutely be competitive within the modern workplace. Work experience with an outside professional employer was designed to be the final RS experiential experience [36]. However, the COVID pandemic massively disrupted the business world during 2020-2021, and internship opportunities were difficult to find for the RS students [37], with roughly only one-third being able to secure an internship over the summer.

The RS students were enrolled in an annual cadre-based one credit hour seminar with the researchers to maintain the program's high-touch status within the students' lives and to direct them to reflect and consider some of the lessons from the experiences they had encountered. Personal reflection in written form is one of the best means to glean positive knowledge from a practical learning event [38], [39]. The students had three extra-curricular activities to cover, and they were assisted by the researchers in producing publication quality final reports. Student essays were peer-edited and then given a final review by the research team. Samples of RS student-written activity reporting were published in an open access / online electronic publication format [40], [41].

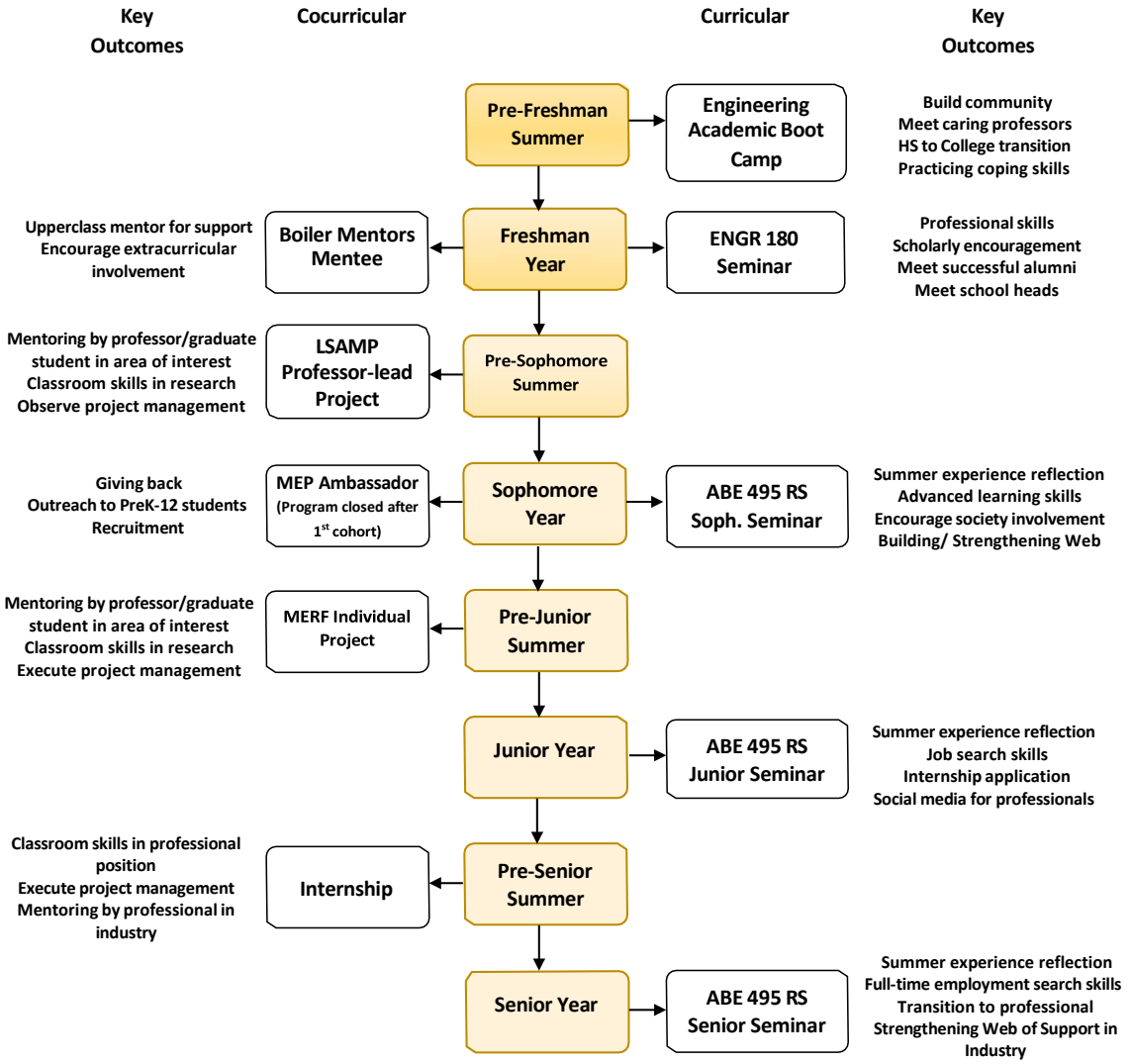
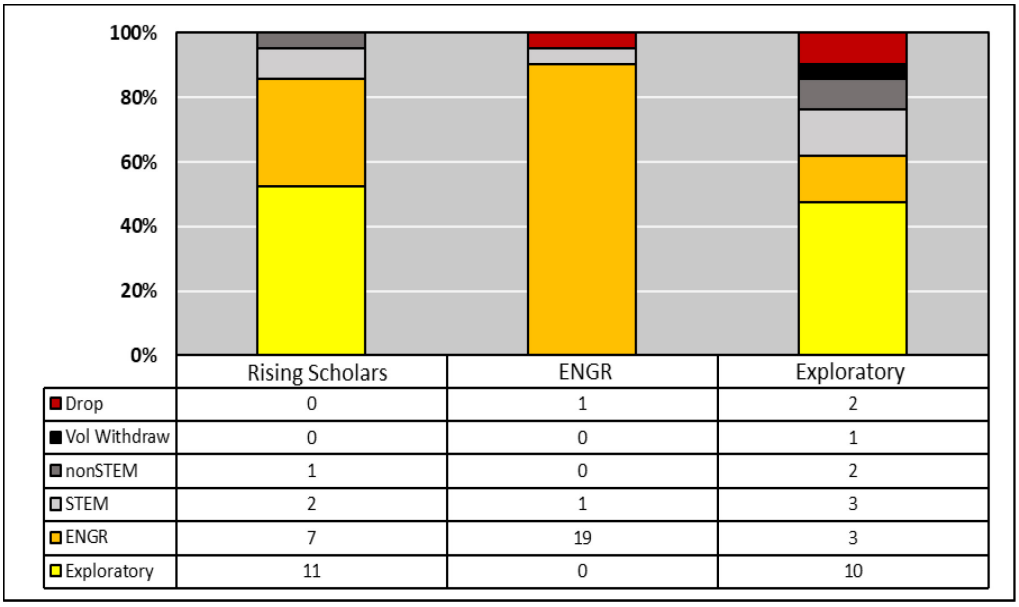


Figure 2 - Rising Scholar recommended "Best Path" through the university, designed to maximize a professional web of support through high-value collegiate contacts [3] (Baldwin, et al., 2023).

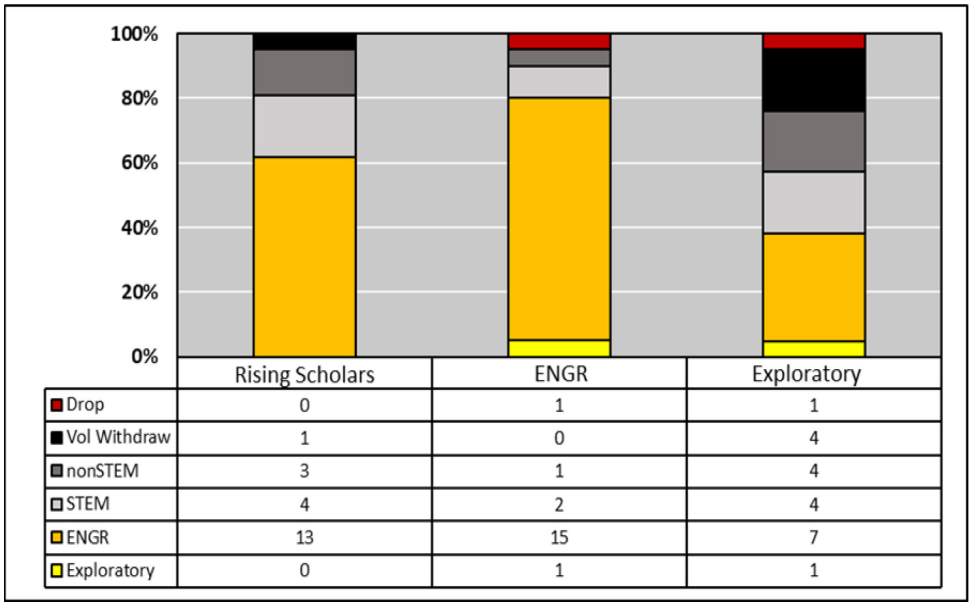
Previous Performance of the Rising Scholars Cohorts

Compared to their matched peer groups in engineering and exploratory studies, the RS students did well initially in both GPA and retention [42]. Engineering students and RS students performed similarly on first year retention, but as shown in Figure 3, RS students were retained at a statistically higher rate than the ES students ($X^2(1)=3.079$, $p=0.040$). There was no statistical significance found between groups for the second-year retention metrics presented in Figure 4. On the other hand, the RS students initially performed much better than their peers in overall grades. Table 1 presents cumulative GPA through Spring 2020.



	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 3 - First Year Retention between Rising Scholars and matched students starting in Engineering and Exploratory Studies [6] (Baldwin, et al., 2021d).



	Rising Scholars	ENGR	Exploratory
Drop	0	1	1
Vol Withdraw	1	0	4
nonSTEM	3	1	4
STEM	4	2	4
ENGR	13	15	7
Exploratory	0	1	1

Figure 2 - Second-year retention between Rising Scholars and matched students starting in Engineering and Exploratory Studies.

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

		1st Year	2nd Year	3rd Year
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	2.88
	Engineering	2.57	2.62	2.50
	Exploratory	2.51	2.59	2.66
F19	Rising Scholar	3.33	3.06	2.88
	Engineering	2.48	2.41	2.35
	Exploratory	2.75	2.60	2.61
Overall Average	Rising Scholar	3.07	3.04	2.99
	Engineering	2.66	2.62	2.58
	Exploratory	2.70	2.69	2.77

Although all RS students accepted into the program met the established program admission criteria, it became apparent that some of the students were flourishing and dramatically increasing their support networks, while others were growing their networks at a much slower pace. A more detailed analysis was conducted to determine the speed that the students were adding university-based mentors into their networks, which then classified the RS students into 'thickly-webbed' and 'thinly-webbed' students [43]. Table 2 shows how much faster the thickly-webbed students began utilizing their university contacts as mentors than did their thinly-webbed counterparts [43]. Further differences between these student groups became apparent during the COVID pandemic. As shown in Figure 5, thickly-webbed students were able to retain their academic focus, while thinly-webbed students struggled [44]. It became obvious that students who understood the power of mentor support networks generally performed academically better than others, even though all students received the same network development training. Figure 6 graphically illustrates the difference between the rate thickly-webbed students acquired new professional mentors compared to the thinly-webbed students [25].

Table 2 - Results of comparing number and type of supporters between the undergraduate STEM students who came in as "Thickly-Webbed" with strong webs of support against those that had weaker webs of support from their initial application through the third year of research [2] (Baldwin, et al., 2022b).

	INITIAL		1st YEAR		2nd YEAR		3rd YEAR	
	Avg. Thickly Webbed	Avg. Thinly Webbed	Avg. Thickly Webbed	Avg. Thinly Webbed	Avg. Thickly Webbed	Avg. Thinly Webbed	Avg. Thickly Webbed	Avg. Thinly Webbed
Parents/Relatives	3.4	1.8	3.4	1.7	3.6	2.0	4.2	1.8
High School People	2.9	0.8	1.0	0.3	0.8	0.3	1.0	0.0
Other	1.4	0.0	1.0	0.3	1.4	0.5	2.1	0.0
Purdue Index			**1.1**	**0.8**	**2.7**	**1.3**	**5.4**	**4.6**
PU Professors(*2)			0.4	0.0	0.8	0.3	1.6	1.8
PU Staff			0.2	0.8	0.8	0.7	1.4	1.0
PU Upperclass(*0.5)			0.4	0.0	0.5	0.0	1.5	0.3

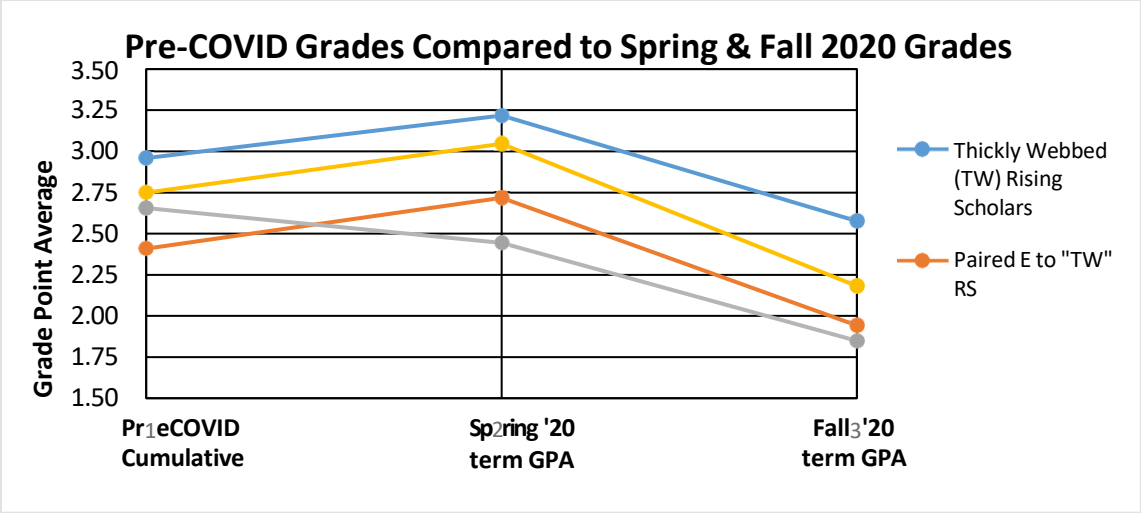
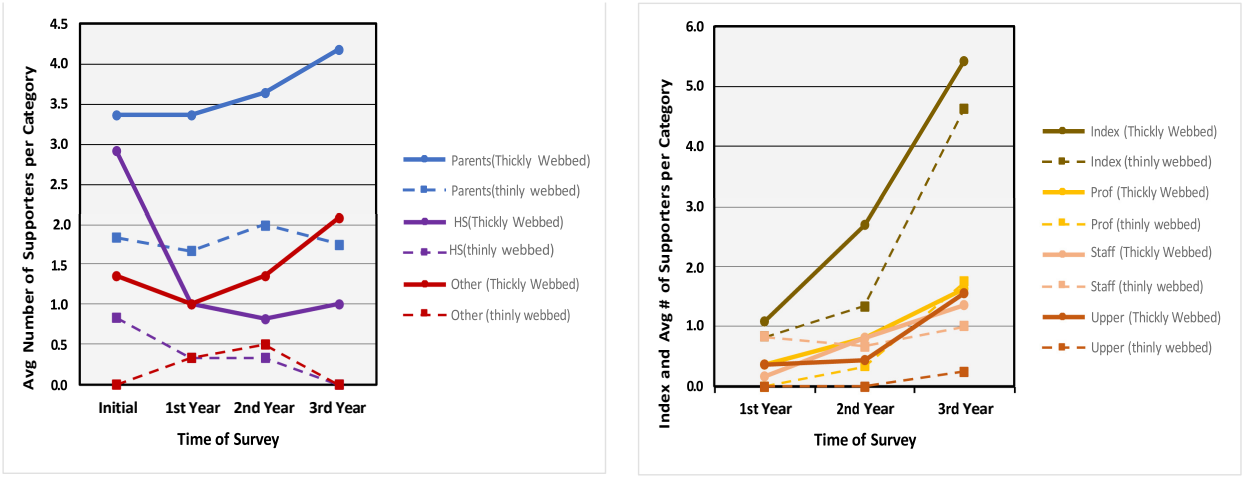


Figure 5 – Comparison between groups of the pre-COVID cumulative GPAs compared to term GPAs during the first two semesters of the pandemic [1] (Baldwin, et al., 2022c).



(A) PreCollege Supporters **(B) Collegiate Campus Supporters**

Figure 6 - Average progression of the average yearly Web of Support between "Thickly Webbed" and "thinly webbed" and split between (A) Pre-College Supporters and (B) Collegiate Campus Supporters [3] (Baldwin, et al., 2023).

The sample size of RS students when disaggregated into thickly and thinly webbed students was too small to allow for any statistical determinations for outcomes. Exit interviews with RS students seemed to show that many of the included elements within the program were helpful. Financial assistance, moral support, and the mechanics of network building were mentioned as useful while in school. No longitudinal post-graduate studies have been undertaken, as some students remain in school, finishing their degrees. Graduation data and the progression for the tracked students through higher education will be presented next.

Graduation Results and Discussion

Four-year retention/graduation data are available for all students, which is presented in Table 3. The Engineering students definitely had the most engineering degrees by the end of

their fourth year at school. These students had the confidence of coming directly into engineering and a more direct path into their final major. There is no statistical difference between the RS and ES students in terms of graduation rates. What can be seen is when looking at students still working on their engineering major, there are more RS than ES students still in school persevering (RS=10 vs ES=3). The STEM and non-STEM majors still have approximately the same number of students enrolled between the three groups. Another difference between the various matched pair groups is that the Rising Scholars did not have any students who had been dropped, but both the engineering (n=3) and the exploratory studies (n=2) had students in that category.

Table 3 – 4th Year Retention/Graduation data for the Rising Scholars and their Engineering and Exploratory Studies matched students n=21 for each group.

	COHORTS -F17, F18, F19 (n=21)		
	Rising Scholars	**Engineering**	**Exploratory Studies**
Bachelor of Science - Engineering	1	9	3
Bachelor of Science - STEM	2	0	3
Bachelor's degree - Purdue	2	1	2
GRADUATED	**5**	**10**	**8**
Agricultural & Biological Engineering	0	1	0
Civil Engineering	2	2	0
Construction Engineering	0	0	2
Electrical & Computer Engineering	2	1	0
Industrial Engineering	3	1	0
Interdisciplinary Engineering	1	0	0
Mechanical Engineering	1	0	0
Materials Engineering	1	0	1
Enrolled ENGR	**10**	**5**	**3**
Enrolled STEM	**2**	**1**	**2**
Enrolled nonSTEM	**1**	**0**	**2**
Voluntarily Withdrawn	3	2	4
Dropped by the University	0	3	2

As seen in Table 4, the fifth-year retention/graduation data becomes essentially just a graduation table for the two cohorts that have reached this milestone. There is one student in the Rising Scholars group who is still working on obtaining a degree in engineering. All STEM and general Purdue degree students have completed their degrees. There have been no Rising Scholar students who have been dropped, which cannot be said for the other two groups. No statistical comparisons can be made, due to the small sample size of these groups.

Table 4 - Fifth-year graduation report of the first two cohorts of Rising Scholars and their comparison students.

	COHORTS - F17, F18 (n=15)		
	Rising Scholars	**Engineering**	**Exploratory Studies**
Bachelor of Science - Engineering	7	9	5
Bachelor of Science - STEM	4	2	4
Bachelor's degree - Purdue	1	1	2
GRADUATED	**12**	**12**	**11**
Electrical & Computer Engineering	1	0	0
Enrolled ENGR	**1**	**0**	**0**
Enrolled STEM (Technology)	**0**	**0**	**0**
Enrolled nonSTEM (Liberal Arts)	**0**	**0**	**0**
Voluntarily Withdrawn	2	1	3
Dropped by the University	0	2	1

Charting the course of these three groups of students through their term at college provides an understanding of how COVID affected their collegiate careers. Figure 7 presents a flow path of the first cohort of students (n=6) in each group. Each student is represented by a gold circle for Rising Scholars, a brown circle for Engineers, and a yellow circle for Exploratory Studies students in each semester. If the student left the university, they are shown with a grey circle for voluntarily withdrawn or a red circle, if they were dropped by the university for academic reasons. All Rising Scholars had chosen their major by the start of their fourth semester and remained in those majors until graduation, which shows the circle with a BS within. Neither RS student nor their matched pair ES student withdrew from the university in this cohort. One Engineering student withdrew after their first year.

The COVID years are highlighted in a red hash pattern. The students had all been in their majors for at least a year, and these students were not significantly affected by COVID. The progress of the second cohort of students (n=9) is presented in Figure 8, and their full five years of higher education can be shown for this group too. These students had COVID hit during the second semester of their sophomore year. There was a bit more movement between the retention stations for the Rising Scholars and their matched pairs. The RS students had 67% of the students graduate in STEM by the five year mark, but one student is still enrolled, and two students have voluntarily withdrawn. All three of these students were in the thinly webbed group. The engineering students had a 56% graduation rate with engineering degrees, which was down from 67% the previous year. Two students are still working on a degree, and two students have been dropped by the university. The Exploratory Studies students had even more movement between majors. The graduation in engineering remained the same for this group (33%); however, they only had a 44% graduation rate in STEM, as compared to an 83% the previous cohort, with three people voluntarily withdrawn, and one person remaining in dropped status. Much of the movement came during the precarious COVID semesters.

Figure 9 really shows the full impact of COVID on students who entered in the Fall 2019 (n=6), which was one semester before the disease hit nationally. Four of the Rising Scholars stayed in Exploratory Studies for the maximum four semesters before choosing a major. More students chose engineering than in the first cohort, and nobody chose a STEM major over a general education. Two engineering RS moved to a second engineering major, and one student moved between the university and remaining at home on alternate semesters. There is not final semester data to allow for a full five year study of all cohorts, but only one of these students received a non-STEM degree in management. The other five remained at school working on a degree. Only half (n=3) of the engineering students chose engineering majors, and this was at a lower rate than in previous years. They had one student that ended the series as withdrawn, and one was dropped from the university. The matched Exploratory Studies students moved into their majors more quickly than the Rising Scholars, but they had a lower number of students choose STEM majors. At the end of 4.5 years, this group has one student who has graduated in engineering, two students with general Purdue degrees, one withdrawn student, and one dropped student.

Student Observations

The researchers intend to collect longitudinal data about the continuing careers of the RS students. The study was conducted within the requirements of Purdue University IRB #1607017964. During a first post-graduation interview [45], [46], [47], [48], [49], the RS students were asked to describe how their participation in the Rising Scholars program had benefited them professionally:

"*I'm here today because of the Rising Scholars program. I honestly would not have made it without the MEP academic boot camp. I met people, who became friends from the Rising Scholars program and friends from the boot camp. If I hadn't met these people, I wouldn't have ever interacted with NSBE, MAES, or SHPE. It all started for me in that first day in Rising Scholars. You guys were just so adamant that if we did what you told us and met the right people, it would all work-out in the end. I'm an Industrial Engineer today, because you exposed me to so much and gave me the opportunity to be a part of it*."

Rising Scholar Eta (Industrial Engineer)

"*The initial experiences provided by the program were wonderful for me. I obviously had a passion for research and science coming into college, but you awakened the collegiate-level passion. The different kinds of research experiences and being able to get published, these were just the confirmation that I needed to know that I had chosen the right field. I also appreciated the community of like-minded people that you built for us. You watered us like plants and helped us grow. Hosting the seminar classes for our groups was really vital too. You gave us so many extra tips that were important to us now as a professionals, like how an interview operates, how to find housing, how to pick a bank. The Rising Scholars program has definitely propelled me further in life than I ever thought I'd go*."

Rising Scholar Pi (Material Science Engineer)

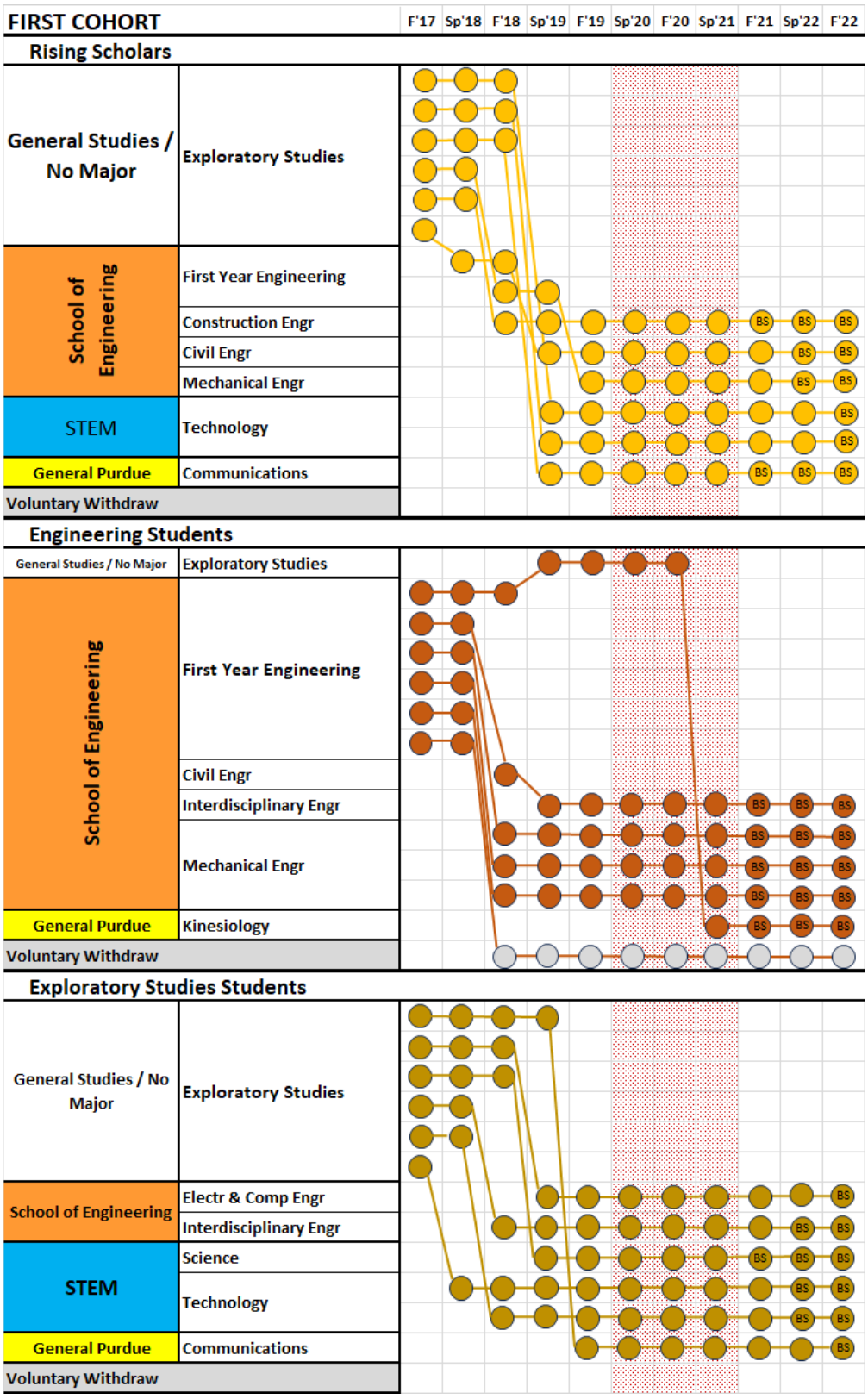


Figure 7 - Diagram of the five-year path of each first cohort student from entry through leaving the university with a degree.

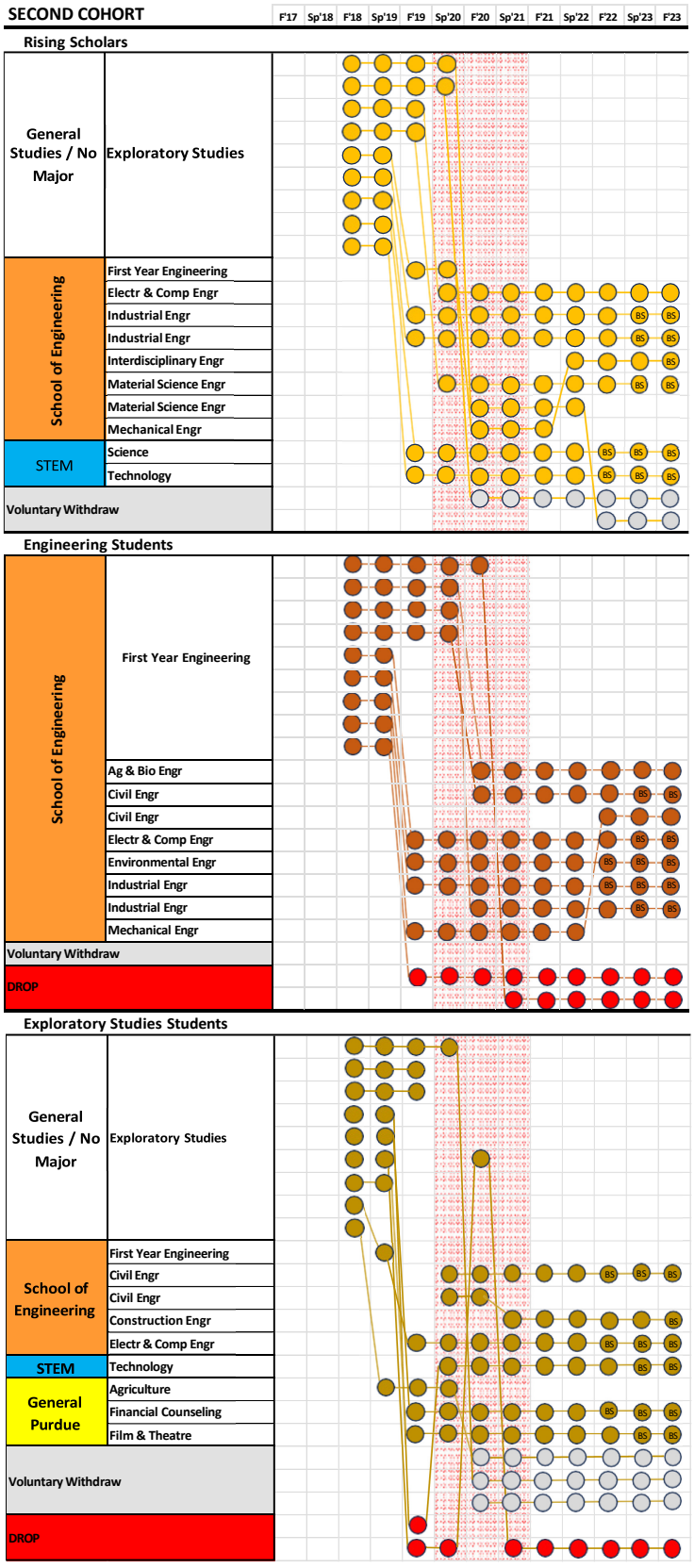


Figure 8 - Diagram of the five-year path of each second cohort student from entry through leaving the university.

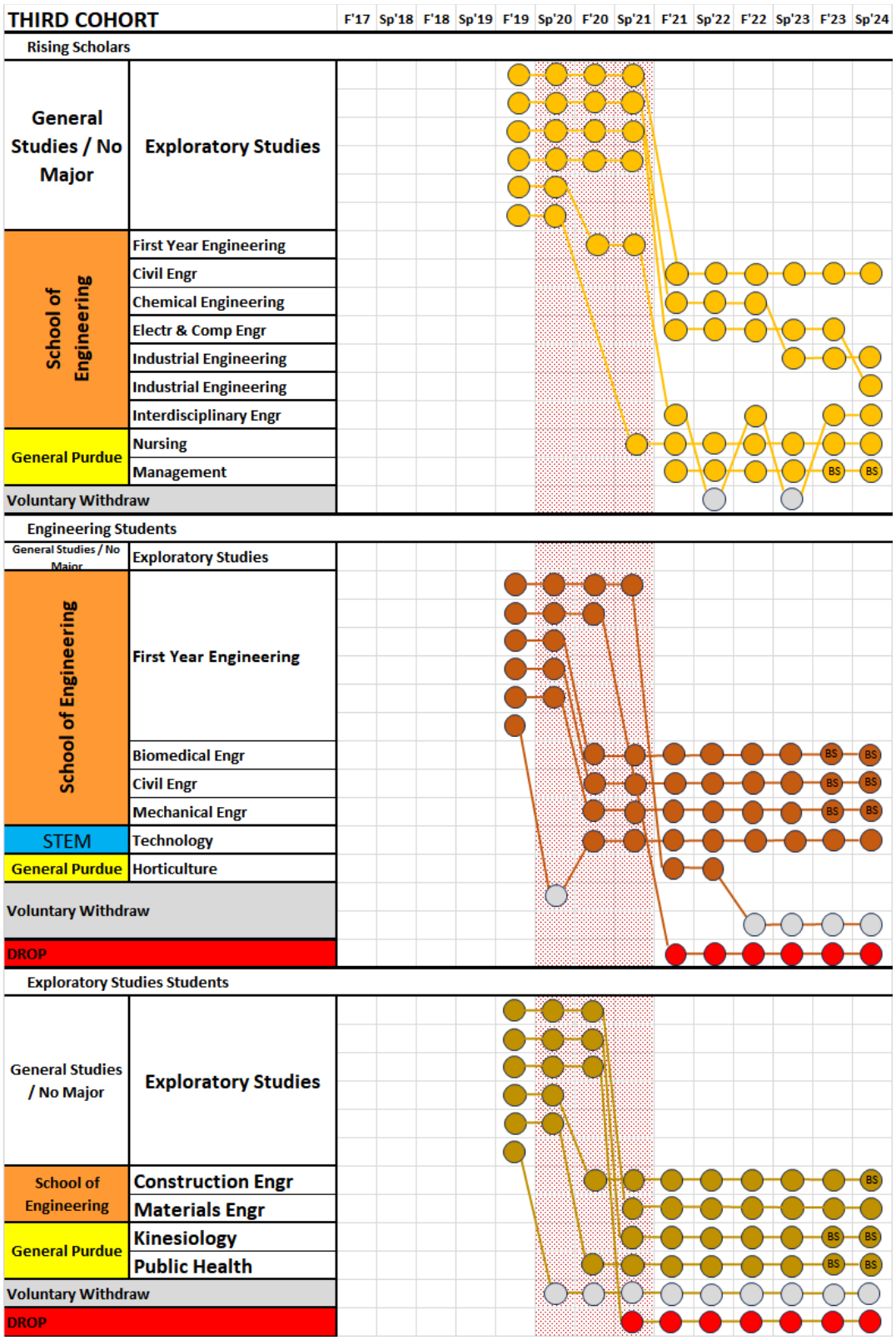


Figure 9 - Diagram of the 4.5-year path of each third cohort student from entry through leaving the university.

"*The Rising Scholars program was great for me. The big thing with you folks was teaching us about how to network, and for me, that's been professionally valuable. I loved the special Peterson talks about mentor support networks and still remember some of his activities. He taught us to cast a wide net for supportive people that could help us, and for me at John Deere, that has been a great strategy. The people that I've just met in one set of circumstances can become colleagues and collaborators in the next. That interconnectedness and ability to work with others was a critical way of thinking about things and professional relationships that I took from Rising Scholars*."

Rising Scholar Epsilon (Mechanical Engineer)

"*There was one moment that I didn't think I'd make it, but it was more stress than academic related. I was just overwhelmed with the amount of things that were going on and the number of commitments that I had. I had stayed-up all night studying, making sure that I was going to do well on an important exam. I was emotionally distraught and did not make my first class that day, but I went to see Dr. Stwalley in MEP, and I got a hug and a sense of perspective. She sat me down and put me back on a sequential path of doing what came next. I did pass my exam, and it reminded me that I am a resilient person and that I actually had what I wanted within my hands. You guys had high expectations for all of us, and for me, I guess I just knew that with you in my corner, I was always going to graduate. I did. I got a great job, and now, I'm sitting in my own house!*"

Rising Scholar Gamma (Engineering Technologist)

"*I think the biggest thing for me was the MEP academic boot camp, where I got to be around a bunch of smart people with huge diverse backgrounds, all trying to study the same general subject as me. It certainly got me to thinking properly about how tough college was going to be. The boot camp environment really allowed me to collaborate and excel academically. It also introduced us to lots of contacts and really helped push me on the social side, dealing with people. I needed that. Those connections really helped get me through my first year engineering classes. Knowing that we were all studying the same material and having contacts to study together with, those things just made it easier for me. Being comfortable enough with someone to bounce ideas off of them is important in collaborative design and for smooth functioning teams. Rising Scholars provided socialization tips and helped us make those classmate connections that got me through school*."

Rising Scholar Zeta (Civil Engineer)

Conclusions

The data presented in this paper combined the retention, academic performance, and personal narrative information to describe the success of the Rising Scholar students within the Purdue NSF program. The COVID pandemic added an additional stressor to these non-standard students in their pursuit of a rigorous academic STEM-based career. However, the Rising Scholars on average were able to show their perseverance and commitment to obtaining a degree during this time. Their own testimonials showed that they credited their success to their affiliation with the RS Program. In summary, the following key findings are important to highlight:

- For cadres 1 & 2, RS students performed and produced outcomes at similar level to students admitted into engineering, despite their initial feelings of disempowerment.
- RS cadre 3, along with all other students during COVID, were hurt badly, but the students with thicker support networks fared better through the troubled times.
- Financial aid packages matter, as out-of-state students with less support faced significantly more collegiate money woes than the in-state students.
- Although a final disaggregation of the students into thickly and thinly webbed students prevented sufficient numbers for statistical comparison, the program has produced 13 collegiate graduates to this point, who would have been unlikely to pursue their passion, unless the Rising Scholars program had supported them.

The Rising Scholar Program has shown that non-majority students with lower incoming metrics can graduate from strong academic programs in engineering and other STEM majors, if they have support networks behind them. The students need to come in the door being introduced to people that can infuse within them the confidence that they will graduate. An entrance-level application question could be introduced that would allow admissions personnel to gain an understanding of how applicants have used their support networks in their high school and seem to have been able to successfully move into their future through the assistance of others. This type of program could be used for any collegiate applicant, whether or not they were a majority individual. The RS program used existing academic components within the institution and would be highly scalable on the curricular side. Financial support and scholarships for low SES students would likely be more difficult to obtain, particularly in today's more restrictive environment. All people that can admit that they have benefited from other's advice and help will likely do well in life, wherever they are placed. The Rising Scholars program simply shows that they will succeed in collegiate-level STEM fields, if given the opportunity. The researchers will continue to remain in contact with the Rising Scholars students and conduct further longitudinal interviews regarding their professional careers.

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References

[1] G. L. Baldwin, V. L. Booth Womack, S. E. LaRose, C. S. Stwalley and R. M. Stwalley III, "A comparison of the academic performance of Rising Scholars with other student demographic groupings before and during the COVID pandemic," in 2022 ASABE Annual Internatinal Meeting - Houston, Texas, St. Joseph, 2022c.

[2] G. L. Baldwin, V. Booth Womack, S. E. LaRose, C. S. Stwalley and R. M. Stwalley III, "Mentoring low-SES students and developing professional support networks," in 2022 ASEE Annual Conference & Exposition (Minneapolis), Washington, DC, 2022b.

[3] G. L. Baldwin, V. Booth Womack, S. E. LaRose, C. S. Stwalley and R. M. Stwalley III, "The development of professional mentors to supplement low socio-economic students' webs-of-support," in 2023 ASEE Annual Conference & Exposition (Baltimore), Washington, DC, 2023.

[4] G. L. Baldwin, V. Booth Womack, S. E. LaRose, C. S. Stwalley and R. M. Stwalley III, "The value of climate in educational programs for diverse student populations within engineering disciplines," in ASABE 2021 AIM - Pasadena, St. Joseph, 2021a.

[5] G. L. Baldwin, V. Booth Womack, S. E. LaRose, C. S. Stwalley and R. M. Stwalley III, "Using broad spectrum technological projects to introduce diverse student populations to Biological & Agricultural Engineering (BAE): a work in progress," in 2021 ASEE Annual Conference & Exposition (Long Beach), Washington, DC, 2021b.

[6] G. L. Baldwin, V. Booth Womack, S. E. LaRose, C. S. Stwalley and R. M. Stwalley III, "Using enhanced professional networks to increase overall student retention," in 2021 ASEE Annual Conference & Exposition (Long Beach), Washington, DC, 2021d.

[7] G. L. Baldwin, V. Booth Womack, S. E. LaRose, C. S. Stwalley and R. M. Stwalley III, "Using support networks as a predictor of success for STEM degrees: preliminary results detailing a selection process for test subjects engaged in a longitudinal study of low socio-economic status American undergraduate students," International Journal of Engineering Pedagogy, vol. 12, no. 6, pp. 16-49, 2022a.

[8] G. L. Baldwin, V. Booth Womack, S. E. LaRose, C. S. Stwalley and R. M. Stwalley III, "Value of experiential experiences for diverse student populations within engineering disciplines: a work in progress," in ASEE Annual Summer Conference (Long Beach), Washington, DC, 2021c.

[9] R. M. Stwalley III, "Assessing improvement and professional career skill in senior capstone design through course data," International Journal of Engineering Pedagogy 7, no. 3, pp. 130-146, 2017.

[10] R. M. Stwalley III, "Definition, mission, and revitalization of cooperative education programs," in 2006 ASEE Annual Conference & Exposition, Washington, DC, 2006a.

[11] R. M. Stwalley III, "Professional career skills in senior capstone design," in ASEE Capstone Conference - Columbus, Washington, DC, 2016.

[12] R. M. Stwalley III, "Survival and success in co-op programs through market analysis and core values," in CEIA 2006 Cincinnati Proceedings, Dallas, 2006b.

[13] R. K. Payne, A framework for understanding poverty, Houston, Texas: aha! Process, Inc., 2013.

[14] L. Weis, K. Cipollone and H. Jenkins, Class Warfare: Class and Race in Affluent and Elite Secondary Schools, Chicago: University of Chicago Press, 2014.

[15] M. M. Holland, "Navigating the Road to College: Race and Class Variation in the College Application Process," Sociology Compass 8/10, no. 10.1111, pp. 1191-1205, 2014.

[16] K. M. Cooper, M. Ashley and S. E. Brownell, "Breaking down barriers: a bridge program helps first-year biology students connect with faculty," Journal of College Science Teaching, vol. 47, no. 4, pp. 60-70, 2018b.

[17] K. M. Cooper, V. R. Downing and S. E. Brownell, "The influence of active learning practices," IJ STEM Ed, vol. 5, no. 23, 2018a.

[18] M. Jury, A. Smeding, N. M. Stephens, J. E. Nelson, C. Aelenei and C. Darnon, "The experiences of low-SES students in higher education: psychological barriers to success and interventions to reduce social-class inequality," Journal of Social Issues, vol. 73, no. 1, pp. 23-41, 2017.

[19] R. S. Mistry and L. Elenbaas, "It's All in the Family: Parents' Economic Worries and Youth's Perceptions of Financial Stress and Educational Outcomes," J Youth Adolescence, vol. 50, pp. 724-738, 2021.

[20] D. Peterson, "Solutions and Outcomes," 2010. [Online]. Available: https://icar-us.com/. [Last accessed 14 May 2020].

[21] D. Peterson, "The Other Side of the Student Report Card: What it is and Why it Matters," in National School Board Association, Boston, 2016.

[22] A. Karimshah, M. Wyder, P. Henman, D. Tay, E. Capelin and P. Short, "Overcoming adversity among low SES students," Australian Universities Review, vol. 55, no. 2, pp. 5-14, 2013.

[23] R. Crosnoe and C. Muller, "Family socioeconomic status, peers, and the path to college.," Social Problems, vol. 61, no. 4, pp. 602-624, 2014.

[24] National Academy of Engineering, "NAE Grand Challenges for Engineering," 2021. [Online]. [Last accessed 12 February 2021].

[25] J. Major and A. Godwin, "Towards Making the Invisible Engineer Visible: A Review of Low-Socioeconomic Students' Barriers Experiencing College STEM Education," in 2018 IEEE Frontiers in Education Conference, San Jose, 2018.

[26] Purdue University, "Louis Stokes Alliance for Minority Participation (LSAMP)," 2020. [Online]. [Last accessed 14 February 2021].

[27] A. S. Browman, M. Destin, K. L. Carswell and R. C. Svoboda, "Perceptions of socioeconomic mobility influence academic persistence among low socioeconomic status students," Journal of Experiemntal Social Psychology, vol. 72, pp. 45-52, 2017.

[28] G. Bolton, "Narrative writing: reflective enquiry into professional practice," Educational Action Research 14, no. 2, pp. 203-218, 2006.

[29] J. McCarthy, "Reflective writing, higher education, and professional practice," Journal for Education in the Built Environment, vol. 6, no. 1, pp. 29-43, 2011.

[30] Organization for Economic Co-operation and Development, "The unequal impact of COVID-19: a spotlight on frontline workers, migrants, and racial/ethnic minorities," 2022. [Online]. Available: https://www.oecd.org/coronavirus/policy-responses/the-

unequal-impact-of-covid-19-a-spotlight-on-frontline-workers-migrants-and-racial-ethnic-minorities-f36e931e/. [Last accessed 17 December 2023].

[31] A. Allison, "The Real Thomas Jefferson," National Center for Constitutional Studies, Malta, Idaho, 1983.

[32] T. Kominiak, "In his words: John Adams on education and democracy," 2019. [Online]. Available: https://www.k12insight.com/trusted/words-john-adams-education-democracy/. [Last accessed 2020].

[33] Kent State University, "Rising Scholars," 2021. [Online]. Available: https://www.kent.edu/stark/rising-scholars. [Last accessed 17 February 2021].

[34] Stanford University, "Stanford GSB Rising Scholars Conference," 2020. [Online]. Available: https://www.gsb.stanford.edu/faculty-research/faculty/conferences/rising-scholars-conference. [Last accessed 17 February 2021].

[35] E. R. Raposa, M. Hagler, D. Liu and J. E. Rhodes, "Predictors of close faculty - student relationships and mentorship in higher education: findings from the Gallop-Purdue index," Annals of the New York Academy of Sciences, vol. 1483, pp. 36-49, 2021.

[36] L. Chopra, "Concept of experiential learning and its importance in present educational systems," International Journal of Research Publication and Reviews, vol. 4, no. 6, pp. 231-233, 2023.

[37] B. M. Holloway, T. Reed, P. K. Imbrie and K. Reid, "Research-informed policy change: a retrospective on engineering admissions," Journal of Engineering Education, vol. 103, no. 2, pp. 274-301, 2014.

[38] M. N. Bastedo, K. C. Glasener, K. C. Dean and N. A. Bowman, "Contextualizing the SAT: Experimental Evidence on College Admission Recommendations for Low-SES Applicants," Educational Policy, pp. 1-30, 2019.

[39] M. N. Bastedo and N. A. Bowman, "Improving Admission of Low-SES Students at Selective Colleges: Results from an Experimental Simulation," Educational Researcher 46, no. 2, pp. 67-77, 2017.

[40] A. Duckworth, C. Peterson, M. D. Matthews and D. Kelly, "Grit: Perseverance and passion for long-term goals," Journal of Personality and Social Psychology 92, pp. 1087-1101, 2007.

[41] Purdue University, "Academic Support and Resources - Engineering Academic Boot Camp," 2023. [Online]. Available: https://www.Purdue.edu/mep/Academic-Support-and-Resources/Engineering-Academic-Boot-Camp.html. [Last accessed 17 December 2023].

[42] American Journal of Rising Scholar Activities Volume 1, R. M. Stwalley III (editor-in-chief), Purdue epubs Document Library, West Lafayette, Indiana, 2022.

[43] American Journal of Rising Scholars Activities Volume 2, R. M. Stwalley III (editor-in-chief), Purdue epubs document library, West Lafayette, Indiana, 2023.

[44] Zeta Rising Scholar, Interviewee, First Post-Graduation Interview. [Interview]. 25 January 2024.

[45] Pi Rising Scholar, Interviewee, First Post-Graduation Interview. [Interview]. 26 January 2024.

[46] Gamma Rising Scholar, Interviewee, First Post-Graduation Interview. [Interview]. 25 January 2024.

[47] Eta Rising Scholar, Interviewee, First Post-Graduation Interview. [Interview]. 26 January 2024.

[48] Epsilon Rising Scholar, Interviewee, First Post-Graduation Interview. [Interview]. 26 January 2024.

[49] D. A. Dickerson, F. Solis, V. L. Booth Womack, T. Zephirin and C. S. Stwalley, "Can an engineering summer bridge program effectively transition underrepresented minority students leading to increased student success?," in 2014 ASEE Annual Conference & Exposition (Indianapolis), Washington, DC, 2014.