

Mentoring Low-SES Students and Developing Professional Support Networks

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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 Past-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.

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Introduction

The Purdue University Rising Scholars program was initially funded in 2016 by NSF S-STEM #1644143 *Rising Scholars: Web of Support Used as an Indicator of Success in Engineering*. The term ‘Rising Scholars’ has come to represent the strata of the population that are of low socioeconomic status (SES) striving to complete a collegiate education (Kent State University, 2021; Stanford University, 2020). The current collegiate entrance metrics favored by many well-regarded state institutions for their STEM programs have certain gateway values, and in general, do not select equitably across many notable factors, including gender; race; ethnicity; first-time, full-time status; and low-SES (Holloway et al., 2014). The general research question addressed by this program was: could the quality of an individual’s adult mentor support network be used as an alternative indicator of potential collegiate and career success? The overall program sought qualified students that had expressed a desire for engineering in their initial application to the university, but had been offered admission into an undeclared major / exploratory studies program. Our process selected individuals that were determined to be “thickly-webbed” than their peers and had numerous quality mentors in their lives that were encouraging them to excel in their academic pursuits (Baldwin et al., 2022).

Students accepted into the program were given a modest scholarship amount that covered about two thirds of their projected academic costs. Once on campus, the program attempted to create a positive, success-reinforcing community of students, similar to those found in minority advocacy organizations and smaller engineering departments (Baldwin et al., 2021a). Students began their collegiate STEM experience with a boot camp designed to emulate the expectations and work load of the first-year engineering program at Purdue, in a consequence-free environment. During each school year, students were provided with a friendly, success-tools oriented seminar by one of the program’s investigators. Reflective writing exercises were emphasized to encourage written communication skills and career focus (McCarthy, 2011; Bolton, 2006). Purdue has found that connections with professionals in college and ownership of some form of experiential activity

provide two of the most significant elements that give general satisfaction to the collegiate experience (Gallup, Inc., 2014). This has been found to be particularly true of self-directed capstone activities (Stwalley, 2017; Utesch, 2016; Stwalley, 2016), and the Rising Scholars researchers incorporated this type of work-related educational activity into the program.

Professional practice organizations have long seen significant advantages given to students with experiential activity at the entry-level (Stwalley, 2006a; Stwalley, 2006b). They also give students significant opportunity to develop relationships with potential professional mentors. The Purdue Rising Scholars program utilized the Lewis Stokes Alliance for Minority Participation program, self-directed research projects, and internships to provide the students' with experiential components during their collegiate experiences (Baldwin et al., 2021b; Baldwin et al., 2021c). The program at Purdue has been operational for five years, and all survey instruments used in this study have been fully approved by the Institutional Research Board. Since the beginning of fall 2017, three successive cadres of 17 active students have been working their way toward graduation. Preliminary data show that the Rising Scholar are performing and being retained in the institution at significantly higher rates than their matched pair partners selected from the general population of students (Baldwin et al., 2021d).

The overall objective of this paper is to present quantifiable information on the Rising Scholars students' adult mentor support networks. This effort begins with a review of the work of Mr. Derek Peterson, who established the concept of measuring mentor networks using Alaskan public school children (Peterson, 2016; Peterson, 2010). Other relevant measures of mentor networks will be examined, and the methodology of measurement in the Purdue program will be explored. The results from the Purdue Rising Scholars students will be presented, along with some positive inferences that can be drawn from the program at this preliminary point.

Literature Review

Derek Peterson's youth mentoring work started in Alaska during the 1990s and has grown across the United States and other places in the world. Two of the major frameworks included within Peterson's analysis were the Social Development Model (SDM) (Catalano et al., 1996) and

the 40 Developmental Assets (40DA) (Benson, 1997). The 40DA program focuses on allowing students to feel empowered by learning to monitor and improve their social development. The SDM posits that youths follow a developmental path with four defining elements, whether they end-up being a productive or a non-productive citizen. The pro-social path will follow positive opportunities, involvement with other pro-social individuals, gaining skills with positive social recognition, and the perception of rewards that can be gained from performing those skills. Similarly, gangs can be thought of as a development path for youth, but the results promote anti-social behavior. (Catalano, et al., 2021) This developmental model is relevant to the Rising Scholar work, since the quicker a student becomes involved on campus with other success-minded students, the better the chance that the positive path will be followed.

Research has shown that a combination of social, emotional, and academic learning has the highest chance of producing a well-rounded individual. (Weissberg & O'Brien, 2004) The 40DA work has been operational for over 30 years, and it presents these ideas using a survey which allows a youth to assess if they feel they are moving on a positive path over time. Outcomes from the program, such as improved self-esteem, higher attendance at school, and better grades, have been demonstrated for low-income, urban, African-American and Hispanic high school students (Scales et al., 2005).

Peterson's Integrative Youth Development™ program has seven factors that the youth can take control of to better their chances of becoming a well-adjusted adult. His research found that while having a nuclear family was a great beginning to life, there were, additionally, other community members that could act as supporters to steer youth away from troubling behaviors. These suppositions exhibited the best positive results with a mix of "it takes a village" and the youth having the ability to take advantage of that village themselves, without outside assistance.

The Rising Scholar researchers acknowledged that the entire set of forty assets were important for gauging the likelihood of a youth's ability to grow into a successful and productive adult. However, potential college students had already shown successful learning processes that allowed them to at least be admitted to an R1, high-selectivity university. Therefore, the web of support (external support assets) would be the primary important area needing cultivation as the student

becomes more distant from their families and needing campus supporters to help move them into adulthood and become productive professional members of society. This was particularly true for first-generation college students whose families are less equipped to understand the new stressors in a college student's life and less able to counsel them in ways to navigate this new environment.

Methodology of Network Evaluation

A survey to be administered to potential students was created which included the Peterson's "Rule of Five", which was one of seven elements used to determine the overall "developmental health" of the youth. This provided information on the number of supporters that a student had in their adult mentor web and how strong the connection was to each supporter. Once accepted into the Rising Scholar program, each student signed a consent form to provide data from surveys and interviews that would take place during their college years to be used for this research. The first fall survey was created to confirm their web of support, determine how much effort they expended in high school to do well, and how much effort they expected was going to be needed for college, and how satisfied they were so far with their university and choice of major. The spring survey was similar to the original application in that it asked for their web of support, but additionally, it required an essay about one instance in which they used their support network during their last year.

The number and strength of the supporters was important for this web of support analysis, as was the connection to student. A goal of the Rising Scholar program has been to grow the students' web of support with university professors and staff. The Peterson youth work dictated that all mentors were adults, but this research expanded possible supporters to include upper-class students. This is moving the student between the youth-model and adult-model mentoring process. Ways to keep strong ties with existing mentors have been discussed in the seminars, but as students moved away from high school, it was anticipated that high school mentors would be replaced by individuals that entered their lives in college. How the students' support networks changed across their collegiate careers was of interest to the researchers.

Students completed the network survey twice per year. The first requested piece of information was the name of the supporter. The identity of the mentor was needed to see how these people moved into or out of the student's support web over time. Longitudinal information could potentially show strengthening as the mentor became better known and more important in the student's life. The various relationships with the students were broken into specific types of adult contacts: parents/relatives; high school teachers or staff; other people could include faith-based individuals, adult family friends, or parents of the student's friends; and Purdue-related supporters could be professors, staff, or upper-class peers. An Index was made for the Purdue supporters which counted professors with a multiplier of two, staff, and upper-classmen with a multiplier of 0.5. This was done to take into account that students feel it is harder to get to know a professor than a classmate who has been at the university longer than themselves. The professor could also potentially provide more professional assistance during the college career and getting into an entry-level position in industry, government, or graduate school.

The strength index of the student's support web was found by answering 10 questions that come from Peterson's proprietary "Success Support Card", shown in Figure 1 (Peterson, 2016). To be a supporting member of the web, an adult would either need to show that they had noticed a student's unique talents and intelligences and/or communicate an elevated expectation of student achievement in school and in life. If one of these first two statements are checked, then the adult becomes a "supporting" member in the student's web, and the total number of all statements that are tallied provides a strength index. A "caring" member in the student's life could have any number of statements checked that did not include these first two, but they are not considered part of the mentoring support web. As more statements on the list are checked, the supporter becomes more tightly connected with the student. The current analysis will only look at those supporters who the students chose as having seven to ten positive statements as the most tightly connected.

This adult (choose all that apply):

- ☐ notices and reminds me of my unique talents, intelligences
- ☐ expects me to achieve in school and in life
- ☐ compliments me when I do the right things right
- ☐ gives me opportunities to have new experiences and learn new things
- ☐ effectively coaches/teaches me the skills I need to be successful in life
- ☐ listens to me and learns about my world, my views, and my ideas
- ☐ lives in a way that if I follow their example will make me a better person
- ☐ makes time for me, no matter what else is happening
- ☐ would do whatever it takes to protect me from harm
- ☐ often puts my needs ahead of their own

Figure 1 - Ways that a person supports a student (Peterson, 2016).

The web of support analysis results will be compared by the students' year (class) in school. Therefore, all freshmen are compared, no matter what year the data was taken. Additionally, it was difficult to get each student to complete their fall and spring survey, and if they did, sometimes they were not as detailed in their description of their web of support in one of their surveys. Therefore, for the analysis reported here, the results from both semesters are combined into all supporters that were listed for each student during the year, no matter if the supporter was presented in the fall or spring semester survey. These results are for the 17 students who have remained active in the program. The student data were randomized between all three cohorts, but results are shown as to whether the student was a male or female. This analysis will preliminarily examine how family members, High School contacts, and Purdue connections are modified as the student matures and moves through college.

Results of the Purdue Rising Scholars Students

Table 1 presents data comparing the differences between the students who came into the Rising Scholar program considered to be "thickly-webbed" (n=11), and those that had a lower number of supporters and/or a weaker connection with the students were "thinly-webbed" (n=6). The goal in recruiting the Rising Scholars was to choose all "thickly-webbed" individuals with at least five individuals as strong mentors, but the potential pool was not large enough. It was felt that the six "thinly-webbed" individuals could benefit from the program and learn how to better use a support network. Determinations on the quality of student webs were made from the initial level of mentor

data self-reported by the students. Students with five or more mentors were considered to be “thickly-webbed”, while those with under five mentors were considered “thinly-webbed”. This determination was based upon their incoming mentor quality index. For the purposes of this study, the mentors listed by the students were divided into four categories: relatives, high school contacts, miscellaneous acquaintances, and Purdue people. There was a general interest in how the university fit into the acquisition of mentors, so a special metric was created for this interaction. The Purdue people were sub-divided into faculty, staff, and classmates to create a weighted Purdue index with faculty members, staff members, and classmates to determine the relative influence of collegiate mentors.

The thickly-webbed group started having stronger family ties (3.4 vs 1.8), but they were also better connected initially with people at their high school (2.9 vs 0.8) and had found support with a wider variety of adults that were around them (1.4 vs 0.0). This data shows that both groups continued to keep similar connections with their families, but the thickly-webbed students continued to have higher support from these people by their third year of the program (4.2 vs 1.8). The individuals from high school rather quickly were reduced in all students’ webs of support, though the most strongly webbed individuals continued to cultivate relationships with their more cherished high school teachers. The thickly-webbed individuals continued the growth of their support web at Purdue. Within the first year, they had started to be mentored by all types of Purdue people. Of note, several thickly-webbed people listed professors in their mentor group initially, but no thinly-webbed listed any professor as tight supporters. The second group had caught-up in numbers of collegiate mentors by the third year, but being able to feel comfortable talking to professors during the stressful freshman and sophomore years could have had the positive effect of getting better grades, having professional references for summer internship opportunities, and feeling more connected to the university. The thinly-webbed group potentially missed these advantages by not having a broader adult support network filled with professional collegiate contacts.

Table 1 - 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.

	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

Conclusions and Continuing Effort

Unfortunately, the sample sizes internal to the current Rising Scholars program at Purdue were too small for statistical inferences to be drawn from the support web results. However, there are general tendencies which do seem apparent. The connection to parents and other relatives appears to remain strong and stable for both thickly-webbed and thinly-webbed low-SES students. Thickly-webbed individuals may even show an increase in family connection with time in college, but more students would be needed to ascertain whether this tendency is significant. It may prove useful to survey the Rising Scholar students as to the specific techniques and practices that they use to keep their family members close to help better inform their less-supported brethren. As expected, adult connections from high school tend to fade as the student becomes more assimilated into collegiate life. Thickly-webbed individuals seem to retain core mentors from this phase in their lives, but thinly-webbed college students seem to fully lose contact with these secondary school role models. However, since both groups increase their overall networks over time, and these earlier high school contacts may not continue to be as relevant, and this circumstance is of less concern than the diminished contact elsewhere. The final point is probably the most interesting from a career development perspective. Both thickly-webbed and thinly-webbed students tend to grow their on-campus networks fairly quickly, but thick-webbed individuals clearly grow them faster. This could be due to multiple reasons, but the potential ramification is the loss of initial

opportunities facilitated by adult mentor support network contacts for the thinly-webbed students, who might actually need the assistance more than their more extroverted colleagues. This result also needs more data before confirmation, but it clearly implies to a critical informational gap for low-SES college students on developing adult professional support mentors. The thinly-webbed students clearly could use additional instruction on finding potential adult mentors and learning how to nurture those relationships.

More definitive results on how low-SES collegiate STEM students' support networks change over time will require larger data sets. The Purdue program will continue to analyze its members' support web results as these students move toward graduation, but a wider sample size will be required before conclusive results can be expressed. Overall, the Purdue Rising Scholars are performing very well compared to their general population counterparts, in both overall grades and retention (Baldwin et al., 2021a). In the future, the research team will be looking to see how the COVID pandemic affected the students' academic and support network performances, as well as their experiences with the Academic Boot Camp, before their matriculation onto campus for undergraduate classes. In general, it can be stated that these low-SES students, when provided with the proper counsel and support, can successfully compete with their peers at a large, R1 institution. Our findings should enable the creation of a larger, more nuanced follow-on program to raise the sample size and demonstrate consistency across multiple institutions for the Rising Scholars segment of the population. The fulfillment of the land grant college promise to American citizens demands that admission to higher education be based on equity and merit. Further research on the progress of Rising Scholars through STEM degrees in higher education will help our society attain that goal.

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Authors

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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.

Virginia L. Booth-Womack 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 industrial assignment was Lean Manufacturing Manager 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 underrepresented minority engineering students and the total engineering cohort, through focusing on first semester performance and first year retention with the implementation of an aggressive transition program targeting first year engineering students from historically underrepresented 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.

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. is 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.

Carol S. Stwalley 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, M.S.A.B.E., and Ph.D. from Purdue University. Carol has more than 14 years in diversity work with considerable background working with the Women in Engineering Programs at Purdue. Although retired from her positions as Recruitment and Retention Analyst for the Minority Engineering Program and the Purdue Office of Institutional Assessment, Dr. Stwalley continues to collect, analyze and manage data pertaining to the outreach, recruitment, retention and graduation of engineering students from historically underrepresented groups at Purdue and other institutions of higher education.

Robert M. Stwalley III joined the Agricultural & Biological Engineering department as a faculty member in the fall of 2013 and is currently an Assistant Clinical Professor. He earned his Bachelor of Science in Agriculture and Biological Engineering 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 past-

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 and has led the Rising Scholars program to help demonstrate that access and support are the most crucial elements to success in higher education for STEM majors.