

## **Improving engineering-student retention via the UC Davis LEADR program**

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Dr. Ralph Aldredge is the Associate Dean for Undergraduate Studies in the College of Engineering, where he provides leadership and oversight for undergraduate enrollment management, orientation and yield efforts, transfer student admissions, academic advising and intervention, retention programs, the Student Start-up Center, ABET degree-program accreditation, assessment training for faculty, and strategic efforts to improve the academic experience. Prior to this administrative role, he served in various academic-senate leadership roles at the department, college, campus and system-wide levels. While serving as chair of the academic-senate committee on admissions and enrollment, he played an integral role in designing the UC Davis holistic-review freshman admissions policy implemented in 2011. He has served also as chair of the UC Board of Admissions and Relations with Schools (BOARS, 2014-2016), which develops and recommends system-wide freshman and transfer admissions policies for approval by the UC Board of Regents.

As a professor in the department of mechanical and aerospace engineering, Dr. Aldredge also performs research and advises graduate students in the areas of combustion, fluid dynamics and bio-transport, with a focus on bio-fluid dynamics (vascular blood flow) and on front propagation both in biological tissue (avascular-tumor dynamics) and in reacting gaseous mixtures (flame propagation). He has developed computational algorithms and software for simulation and analysis of flame propagation, including an iPhone/iPad application (the Level-Set app).

Dr. Aldredge received a BS degree in Mechanical Engineering and French at Carnegie-Mellon University and his Master's and PhD degrees in Mechanical and Aerospace Engineering at Princeton University. He completed postdoctoral fellowships at UC San Diego and Caltech prior to arriving at UC Davis to begin his teaching career.

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### ***Abstract:***

The impact of the Leadership in Engineering Advancement, Diversity and Retention (LEADR) Program on the retention of engineering undergraduates at UC Davis is evaluated. First-year retention rates for first-generation, female and URM program participants are found to be higher than those for their non-LEADR engineering undergraduate counterparts, while positive program impact on retention is found generally to be lacking for participants during their second and third years of study. Program enhancements to address and improve second- and third-year retention rates are discussed.

### ***Background:***

The mission of the LEADR Program is the retention and graduation of a diverse population of undergraduate students from the College of Engineering (COE) at University of California, Davis. Services include academic advising, freshman engineering seminars, a residential-hall living-learning community, a summer bridge program for freshmen matriculates, and a designated space for individual and collaborative group study. Individualized tutoring and co-curricular supplementary Calculus and Physics courses (referred to as “co-courses”) are provided during the academic year through the Academic Assistance and Tutoring Center, a campus partner.

The LEADR program has grown from an initial cohort of 35 students in 2012 to now serve over 300 students each year. LEADR students often attribute their persistence in engineering to their participation in this program, which creates a sense of belonging and being part of a “family away from home”. The residential-hall living-learning community, established in 2017, has been especially impactful in this creating a sense of community among the program participants.

Established in 2016, the LEADR Summer Bridge program is a week-long pre-matriculation transition program held during the week before the beginning of the fall academic quarter to help students who are primarily, first-generation and members of an under-represented minority (URM) group (identifying as Chicax/ Latinx, African American, and American Indian), prepare for their first year of engineering studies at UC Davis. The program hosts students from many counties throughout the state of California.

### ***Pre-matriculation Summer Bridge program provides:***

- Professional development, problem-solving and team-building activities; and workshops hosted by industry recruiters and professional engineers focusing on building essential interpersonal skills
- Exposure to the “Day in the Life of an Engineer” through interactive professional panels
- Tours of engineering companies to give students the chance to see “engineers at work” and hear summer interns and recent engineering graduates share their experiences with transitioning from college into the workforce

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- Presentations by alumni who share how they navigated engineering coursework, club involvement, leadership roles, etc. and their work their experiences post-graduation in either graduate school or the workforce
- Mock professor office hours to help students become comfortable approaching their instructors for assistance with course material and seeking opportunities for academic-enrichment (e.g., undergraduate research and mentoring)
- Physics and calculus workshops led by teaching specialists at the UC Davis Academic Assistance and Tutoring Center
- Mentoring from junior- and senior-class LEADR students, who live and dine with the students during their residential experience and provide their perspectives and advice on navigating the college experience.

***LEADR Program Outcomes:***

Table 1 shows LEADR-program demographics and retention rates for disaggregated subgroups of program participants, compared with those of non-LEADR engineering students who first enrolled at UC Davis as freshman. Transfer engineering students, who matriculated at UC Davis for upper-division study, are excluded from the analysis since these students are not invited to participate in the LEADR program. The LEADR cohort is defined as the group of students who participated in the LEADR Summer Bridge program in the summer immediately preceding their first Fall quarter at UC Davis. The cohort of non-LEADR students is defined as the group of non-LEADR freshman counted at on the fifteenth day of instruction in the same Fall quarter. Retention is defined as continued enrollment as an engineering major after the respective one-year, two-year or three-year periods denoted in the table. For example, first-year retention for the 2019 cohort denotes verified enrollment of these students in Fall 2020. Participants who switch to a non-engineering major but remain enrolled at UC Davis are considered to have not been retained. The earliest year for which data is presented is 2017, when the impactful Summer Bridge and residential-hall living-learning experiences became first available.

The diversity of LEADR participants is significantly greater than that of the larger population of engineering undergraduates who matriculated as freshmen (denoted “COE”). For example, as shown in Table 1a, 78.8% of LEADR participants who enrolled in Fall 2020 were first-generation students (having parents without a college degree), 57.5% were female and 63.8% were members of a URM group versus 31.5%, 37.7% and 26.1%, respectively, for the larger COE population. Overall, 8.7% of all engineering students who enrolled as freshmen in Fall 2020 were LEADR participants, as were 24.7%, 15.1% and 24.2% of all first-generation, female and URM students in this cohort (respectively).

Tables 1b, 1c and 1d show first-year, second-year and third-year retention rates (respectively) for LEADR participants versus non-LEADR and all engineering undergraduates who first enrolled as freshmen (“COE”). Retention rates for the disaggregated first-generation, female and URM students subgroups are also shown. Because of the substantial demographic differences between LEADR and non-LEADR participants noted above, retention rates for the disaggregated first-generation, female and URM students subgroups are also shown. Table 1b shows that while the first-year retention rate for LEADR participants who matriculated in 2019 is the same as that for non-LEADR participants in the same cohort (and only slightly higher for the 2017 and 2018 cohorts), it is significantly higher for LEADR participants when comparisons are made for each of the disaggregated subgroups. For example, the first-year retention rate for first-generation LEADR participants who enrolled in Fall 2019 was 88.2%, versus 82.9% for the first-generation subgroup of non-LEADR students. For the female and URM subgroups, the first-

year retention rates for this cohort were 90.2% and 85.5% (respectively) for LEADR participants versus 86.3% and 83.8% (respectively) for non-LEADR students.

Table 1c shows the rates of second-year retention for the 2017 and 2018 cohorts of LEADR participants versus those for non-LEADR students and the overall COE population. Only for the subgroup of first-generation students are the second-year retention rates significantly higher for LEADR participants in comparison with those for non-participants. For the URM subgroup, no significant differences in the second-year retention rates are found when comparing LEADR participants with non-participants. For the female subgroup, the second-year retention rates are lower for LEADR participants than for non-participants. This is found to be the case also when comparing the aggregate groups of all LEADR participants and non-participants. Lastly, the third-year retention rate for students who enrolled in 2017 is found to be lower for LEADR participants than for non-participants for both the aggregate and all subgroups.

***Discussion:***

Until recently, the LEADR program has provided support primarily to students in their freshman and sophomore years. Most LEADR students participate in the pre-matriculation Summer Bridge program described above and also enroll in an academic-success course (restricted to LEADR students) during the fall and winter quarters of their freshman year. Some chose to also live in the LEADR residential-hall living-learning community, intended to enhance their sense of belonging and their confidence of academic success. In 2020, we were successful in receiving a three-year award from the UC Davis Office of the Provost to enhance to LEADR program, which allowed us to hire additional staff support focused on improving second- and third-year retention rates as well as graduation rates and time-to-degree. The additional staff support will provide opportunities for holistic advising, career guidance and facilitated mentorships to continue beyond the second year of enrollment. In addition, the first-year academic-success course will be enhanced to include a project focused on the NAE Grand Challenges<sup>2</sup>, which will provide an opportunity for students to develop the team-building and presentation skills that will be needed in required upper-division engineering design courses.

In addition, we were successful in receiving a grant from the National Action Council for Minorities in Engineering (NACME), along with matching funds from the College of Engineering and the Offices of the Chancellor and Provost at UC Davis, to further support the LEADR program. With funding from this grant, we have identified twenty-four LEADR participants who will each receive up to four years of scholarship assistance, career guidance and additional mentoring support. These NACME Scholars are selected through a competitive application process based on their demonstrated commitment towards or interest in eliminating the barriers preventing full participation of students from traditionally under-represented ethnic backgrounds; specifically, those who identify as Black/African-American, Latinx/Hispanic-American or Native/American Indian. We expect that the recently received Provost award and NACME grant funding, which will allow us to provide career guidance and additional advising and mentoring support to LEADR participants beyond the freshman year, will lead to second improved second- and third-year retention rates, graduation rates and reduced time-to-degree.

In addition to the program changes described above, we are collecting data on the levels of student engagement with each program support component (i.e., the summer-bridge program, the residential-hall living-learning community, the student-success course, cohort-building activities, advising and mentoring, etc.) to be correlated with cohort academic performance and retention rates. We expect that

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<sup>2</sup> NAE Grand Challenges: <http://www.engineeringchallenges.org>

the evaluation of these correlations along with the results of student surveys will provide the additional insight needed to further develop strategies to improve student retention and success.

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**Table 1: Demographics and Retention rates**

1a: Cohort Demographics	2017			2018			2019			2020		
	LEADR	non-LEADR	COE	LEADR	non-LEADR	COE	LEADR	non-LEADR	COE	LEADR	non-LEADR	COE
Subgroup disaggregation (freshman matriculates only)	63	860	923	93	741	834	104	734	838	80	729	809
Representation among all students in COE	6.8%	93.2%	100%	10.1%	88.8%	100%	11.3%	87.6%	100%	8.7%	90.1%	100%
First-Generation (FG)	48	262	310	87	260	347	85	211	296	63	192	255
Representation of FG in subgroup	76.2%	30.5%	33.6%	93.5%	35.1%	41.6%	81.7%	28.7%	35.3%	78.8%	26.3%	31.5%
Representation among all FG in COE	15.5%	84.5%	100%	25.1%	74.9%	100%	28.7%	71.3%	100%	24.7%	75.3%	100%
Female	21	245	266	41	243	284	51	234	285	46	259	305
Representation of Female in subgroup	33.3%	28.5%	28.8%	44.1%	32.8%	34.1%	49.0%	31.9%	34.0%	57.5%	35.5%	37.7%
Representation among all Female in COE	7.9%	92.1%	100%	14.4%	85.6%	100%	17.9%	82.1%	100%	15.1%	84.9%	100%
URM	45	177	222	76	159	235	76	159	235	51	160	211
Representation of URM in subgroup	71.4%	20.6%	24.1%	81.7%	21.5%	28.2%	73.1%	21.7%	28.0%	63.8%	21.9%	26.1%
Representation among all URM in COE	20.3%	79.7%	100%	32.3%	67.7%	100%	32.3%	67.7%	100%	24.2%	75.8%	100%

1b: First-Year Retention	2017			2018			2019		
	LEADR	non-LEADR	COE	LEADR	non-LEADR	COE	LEADR	non-LEADR	COE
Subgroup disaggregation (freshman matriculates only)	63	860	923	93	741	834	104	734	838
Students in subgroup who were retained in COE	52	701	753	81	632	713	90	635	725
Retention rate	82.5%	81.5%	81.6%	87.1%	85.3%	85.5%	86.5%	86.5%	86.5%
First-Generation (FG)	48	262	310	87	260	347	85	211	296
FG retained	39	194	233	76	209	285	75	175	250
Retention rate	81.3%	74.0%	75.2%	87.4%	80.4%	82.1%	88.2%	82.9%	84.5%
Female	21	245	266	41	243	284	51	234	285
Female retained	19	195	214	34	199	233	46	202	248
Retention rate	90.5%	79.6%	80.5%	82.9%	81.9%	82.0%	90.2%	86.3%	87.0%
URM	45	177	222	76	159	235	76	148	224
URM retained	35	130	165	66	128	194	65	124	189
Retention rate	77.8%	73.4%	74.3%	86.8%	80.5%	82.6%	85.5%	83.8%	84.4%

1c: Second-Year Retention	2017			2018		
	LEADR	non-LEADR	COE	LEADR	non-LEADR	COE
Subgroup disaggregation (freshman matriculates only)	63	858	921	93	741	834
Students in subgroup who were retained in COE	39	557	596	64	533	597
Retention rate	61.9%	64.9%	64.7%	68.8%	71.9%	71.6%
First-Generation (FG)	48	260	308	87	260	347
FG retained	28	142	170	60	160	220
Retention rate	58.3%	54.6%	55.2%	69.0%	61.5%	63.4%
Female	21	245	266	41	243	284
Female retained	12	146	158	24	164	188
Retention rate	57.1%	59.6%	59.4%	58.5%	67.5%	66.2%
URM	45	175	220	76	160	236
URM retained	23	89	112	50	106	156
Retention rate	51.1%	50.9%	50.9%	65.8%	66.3%	66.1%

1d: Third-Year Retention	2017		
	LEADR	non-LEADR	COE
Subgroup disaggregation (freshman matriculates only)	63	858	921
Students in subgroup who were retained in COE	31	527	558
Retention rate	49.2%	61.4%	60.6%
First-Generation (FG)	48	260	308
FG retained	20	137	157
Retention rate	41.7%	52.7%	51.0%
Female	21	246	267
Female retained	10	139	149
Retention rate	47.6%	56.5%	55.8%
URM	45	175	220
URM retained	19	88	107
Retention rate	42.2%	50.3%	48.6%