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A Measurement of Systemic STEM Educational Wellness at a Minority-Serving Institution Using the Eco-STEM Educational Ecosystem Health Survey

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Abstract

This research paper presents preliminary results of the Educational Ecosystem Health Survey (EEHS), a survey instrument designed by the Eco-STEM team at California State University, Los Angeles, a regionally serving, very high Hispanic-enrolling Minority Serving Institution (MSI). The purpose of the instrument is to quantitatively measure the health of the STEM educational ecosystem from the perspectives of the actors within it. The Eco-STEM team is implementing an ongoing NSF-funded research project aiming to change the paradigm of teaching and learning in STEM and its aligned mental models from factory-like to ecosystem-like. We hypothesize that this model of education will better support students and their individual needs. The pilot results of administering the EEHS to students within the College of Engineering, Computer Science, and Technology and the College of Natural and Social Sciences provide a baseline from which the Eco-STEM team will analyze diversion – and, hopefully, improvement – over the coming years of the project.

The pilot survey was administered to undergraduate and graduate students at California State University, Los Angeles, of which the majority have ethnically- and socioeconomically-minoritized backgrounds. The EEHS is comprised of validated survey instruments that query students' perceptions of various aspects of systemic educational health. These instruments measure the constructs of *Classroom Comfort*, *Faculty Understanding*, *Belongingness, Thriving, Mindfulness*, and *Motivation.* T-tests and ANOVA models are employed to analyze variations in responses among students based on a host of demographic identifiers. Pilot results from the first administration of the survey include, for example, statistically significant lower reported levels of thriving and mindfulness for students who identify as LGBTQIA+ than those who do not, as well as far lower levels of ecosystem health overall for students who do not have access to stable housing. Additional statistically significant results are identified on the bases of students' gender, race/ethnicity, disability status, veteran status, undergraduate versus graduate student status, college of study, employment situation, and more detailed housing situation.

The pilot results of the EEHS provide detailed insight into the experiences and needs of students in STEM programs at MSIs and regionally serving institutions. The results may also be useful within the contexts of a diverse range of institutions as they strive to serve students from historically marginalized backgrounds.

Keywords: *Surveys, Climate, Belonging, LGBT+, Housing Insecurity, Minority-Serving Institutions*

Introduction

California State University, Los Angeles (Cal State LA) is a teaching-focused, public institution of higher education located on the East side of Los Angeles. There are 23,298 undergraduate and 3,734 graduate students enrolled at the university, as of April 2022 [1]. The function of the university is to serve the local population of the region in which it is located. 95% of students are commuters [2], and over a third of the student body are transfer students, predominantly from the large network of community colleges serving the East side of Los Angeles. A very high Hispanic-enrolling Minority Serving Institution (MSI), 70% of students identify at Hispanic/Latinx [1], which is also consistent with the regional population.

Student demographic characteristics at Cal State LA are also reflective of the systemic oppression broadly experienced by Communities of Color on the East side of Los Angeles. The median family income of students at Cal State LA is $40,300 per year [3], and 60% qualify for federal Pell Grants [4]. While exact data is not readily available, about 2% of students in the California State University system are undocumented [5], and 11% experience housing insecurity [6]. Food insecurity is a rampant problem. Public K-12 educational quality is a challenge due to chronic underfunding, and 81% of students at Cal State LA do not have a parent with a bachelor's degree [4].

Within this context, it is highly difficult for students at Cal State LA to complete their degree programs. As of October 2022, 4-year graduation rates were 10.5% and 21.7% for undergraduate students in the College of Engineering, Computer Science, and Technology and the College of Natural and Social Sciences, respectively, and 6-year graduation rates increased only to 30.3% and 36.9% [4]. Many college- and university-level initiatives have attempted to address poor retention rates by implementing interventions intended to support student success, but none have resulted in extremely dramatic changes to the educational system or to students' overall outcomes within it.

Conceptual Framework

The Eco-STEM team at Cal State LA employs an alternative theory of change for the STEM higher educational system. Rather than view a university as a factory, in which the inputs, students, are expected to be uniform and met with initiatives meant to "correct" them when they are deemed "deficient", we attempt to utilize the mental model of an ecosystem to instead understand how actors within the system relate to one another, recognizing that every actor is different and every relationship is different [7]. A healthy ecosystem, in our framework, is one in which everyone is valued and supported according to their own individual needs. These needs are greatly impacted by systems of social oppression, which disproportionately affect our students. We also recognize that these systems of oppression are active within the university itself, and even within our own classrooms. To build STEM educational systems that prioritize equity and justice, we require the development of the critical consciousness [see 8] necessary for faculty to begin to understand how systems of oppression are reproduced, albeit often unintentionally, within their own classrooms. To this end, the Eco-STEM project has developed

Communities of Practice for faculty and department chairs, which are described in [9] and [10], respectively. By changing the mental models of these powerful actors within the educational system, we hope to address head-on the "roots" of educational inequity, rather than reacting to its symptoms.

Methods

To test the theory of change of the project, a quantitative, Likert-scale survey, which we refer to as the Educational Ecosystem Health Survey (EEHS) is distributed to students, staff, and faculty in the College of Engineering, Computer Science, and Technology and the College of Natural and Social Sciences at Cal State LA each semester, which began with its administration in the Spring 2022 semester. The administration of the survey was approved by the Institutional Resource Board. Ten VISA gift cards were raffled to the respondents to provide incentive to complete the survey. 517 students responded to the survey in English. A Spanish language version of the survey was offered, but only 3 students chose to take the survey in Spanish. We only consider English responses in this study, considering that we lack sufficient responses to validate the translation of our survey into Spanish. 74 of these survey responses did not include any responses to the demographic items that were included after the Likert-scale questions, so these responses are excluded from this study. Thus, this study analyzes 443 student responses.

The Likert-scale survey questions consisted of 15 existing survey constructs, all of which had previously been validated in higher educational contexts. These constructs are described in [11]. These constructs were intended to measure the "health" of the educational ecosystem from the perspectives of the actors within it. Upon further statistical validation with our dataset, many of the constructs did not meet standards of internal consistency when applied to our student population (publication forthcoming); thus, the results of these constructs are not presented in this study. The dependent variables in our study are measured by the responses to the six constructs that successfully validated. These measure students' perceptions of *classroom comfort, faculty understanding, belongingness, thriving, mindfulness,* and *motivation*. These survey constructs are shown in Table 1.

The demographic identifiers queried include: gender identity, race/ethnicity, LGBTQIA+ status, multilingualism, socioeconomic status, disability status, veteran status, first-generation student status, legal status, living/housing situation, employment status, full/part-time student status, undergraduate/graduate student status, year in program, and frequency of in-person study. Results from undergraduate students are additionally disaggregated by transfer status and field of study, and those from graduate students are by whether the student completed their undergraduate degree at the same institution as well as by field of study. To provide more information on the impact of living/housing situation on educational health measures, students who live off-campus are asked to provide the average duration of their commute, and those who live off-campus are asked whether they live with the individuals who raised them as children and whether they have responsibilities to care for children themselves. This demographic information

Table 1: Dependent Variables

Variable	Construct and Source	Survey Items (Adapted)
Classroom Comfort	"Perceived Classroom Comfort" from Hoffman et al.'s "Sense of Belonging Scale" [12]	Please rate your agreement with the following statements, which relate to your comfort levels about having discussions, academic, personal, or otherwise, with members of the Cal State LA community. • Speaking in my classes is easy because I feel comfortable. • I feel comfortable volunteering ideas or opinions in my classes. • I feel comfortable contributing to discussions in my classes. • I feel comfortable asking a question in my classes.
Faculty Under-standing	"Empathetic Faculty Understanding" from Hoffman et al.'s "Sense of Belonging Scale" [12]	Please rate your agreement with the following statements, which relate to your comfort levels about having discussions, academic, personal, or otherwise, with members of the Cal State LA community. • I feel that my professors would take the time to talk to me if I needed help. • I feel that my professors would be sympathetic if I was upset. • I feel that my professors would be sensitive to my difficulties if I shared them. • I feel that my professors really try to understand my problems when I talk about them.
Belonging-ness	"Engineering Belongingness Scale" from Scheidt et al.'s "SUCCESS Survey" [13], developed from prior work [14-16]	The following items are about how you feel that you fit in your major and belong in this community. Please rate your agreement with the following statements. • I feel comfortable in my major. • I feel I belong in my major. • I enjoy being in my major. • I feel comfortable in classes in my major. • I feel supported in classes in my major. • I feel that I am part of classes in my major.
Thriving	"Brief Inventory of Thriving" from Su et al. [17]	Please rate your agreement with the following statements, which are related to your experience at Cal State LA. • There are people who appreciate me as a person. • I feel a sense of belonging in my community. • In most activities I do, I feel energized. • I am achieving most of my goals. • I can succeed if I put my mind to it. • What I do in life is valuable and worthwhile. • My life has a clear sense of purpose. • I am optimistic about my future. • My life is going well. • I feel good most of the time.

Mindful-ness	"Mindfulness Attention Awareness Scale" from Rieken et al. [18], developed from the prior work of Brown and Ryan [19]	Below is a collection of statements about your everyday experience at Cal State LA. Using the scale below, please indicate how frequently or infrequently you currently have each experience. Please answer according to what really reflects your experience rather than what you think your experience should be. Please treat each statement separately from every other statement. • It seems I am "running on automatic," without much awareness of what I'm doing. • I rush through activities without being really attentive to them. • I do jobs or tasks automatically, without being aware of what I'm doing. • I find myself doing things without paying attention.
Motivation	"Perceptions of the Future" from "Future Time Perspective" within Scheidt et al.'s "SUCCESS Survey" [13]	The following questions relate to your attitudes and beliefs about your experiences within your major. Please rate your agreement for each statement. • I am confident about my choice of major. • Going into my current major is the most rewarding future career I can imagine for myself. • My interest in my major outweighs any disadvantages I can think of. • I want to work in my major.

serves as the independent variables in our analyses of students' perceptions of educational ecosystem health.

The administration of the EEHS each semester allows us to track any significant changes in the reported "health" of the educational ecosystem over the lifetime of the project. In this study, we present the initial results of the survey upon its first administration. These results will serve as a "baseline" from which deviation will be measured from results in future semesters. Assuming interval data (which appeared to be a reasonable assumption given the average skewness and kurtosis of the validated constructs), means and standard deviations of the construct were calculated for each demographic population and for each of the six dependent variables, assuming equal weighting of all survey items. To compare results between demographic populations, t-tests were conducted to test for statistical significance across two groups. Likewise, one-way ANOVA was used to compare results across three or more groups.

Results and Discussion

The average and standard deviation for each construct, disaggregated by demographic population, are shown in Table 2. The statistical significance of discrepancies between various demographic populations' responses, determined through t-tests and AVONA, are shown in Table 3. The results of each of the six constructs are described below.

Table 2: Means and standard deviations of baseline EEHS results

Mean (standard deviation) for constructs within student populations ***(Likert Scale from 1-5, where 5 is the most positive response)***			**Class-room Comfort**	**Faculty Under-standing**	**Belong-ingness**	**Thriving**	**Mindful-ness**	**Motiv-ation**
Independent Variable	***Variable Categories***	***'n'*** [+]						
	Undergraduate	**332**	**3.42 * (1.26)**	**3.60 * (1.12)**	**3.88 * (1.11)**	**3.85 * (1.10)**	**3.35 * (1.19)**	**4.11 (1.09)**
	Graduate	**65**	**3.73 * (1.19)**	**3.71 * (1.17)**	**4.22 (1.10)**	**3.88 * (1.19)**	**3.41 * (1.14)**	**4.26 (1.05)**
	Full-Time	**339**	**3.47 * (1.24)**	**3.63 * (1.13)**	**4.05 (1.07)**	**3.85 * (1.10)**	**3.33 * (1.18)**	**4.13 (1.08)**
	Part-Time	**58**	**3.47 * (1.36)**	**3.51 * (1.14)**	**4.06 (1.22)**	**3.86 * (1.20)**	**3.50 * (1.19)**	**4.18 (1.14)**
Year in Program	**1st**	**160**	**3.54 * (1.22)**	**3.62 * (1.09)**	**4.11 (1.07)**	**3.90 * (1.07)**	**3.44 * (1.14)**	**4.21 (1.05)**
	2nd	**101**	**3.31 * (1.35)**	**3.61 * (1.22)**	**3.98 * (1.16)**	**3.78 * (1.20)**	**3.27 * (1.24)**	**4.02 (1.16)**
	3rd	**58**	**3.44 * (1.25)**	**3.73 * (1.04)**	**3.99 * (1.15)**	**3.88 * (1.01)**	**3.36 * (1.20)**	**4.16 (1.02)**
	4th	**35**	**3.60 * (1.26)**	**3.44 * (1.16)**	**4.11 (1.02)**	**3.85 * (1.02)**	**3.22 * (1.13)**	**4.13 (1.04)**
	5th	**21**	**3.57 * (0.96)**	**3.74 * (1.11)**	**4.08 (1.08)**	**3.90 * (1.16)**	**3.48 * (1.18)**	**4.26 (1.00)**
	6th +	**22**	**3.50 * (1.31)**	**3.53 * (1.17)**	**4.10 (0.99)**	**3.82 * (1.37)**	**3.23 * (1.26)**	**3.93 * (1.27)**
	First-Gen	**291**	**3.46 * (1.17)**	**3.63 * (1.15)**	**4.04 (1.09)**	**3.87 * (1.12)**	**3.40 * (1.19)**	**4.15 (1.08)**
	Not First-Gen	**97**	**3.48 * (1.24)**	**3.55 * (1.08)**	**4.05 (1.12)**	**3.78 * (1.13)**	**3.25 * (1.15)**	**4.12 (1.13)**
Living / Housing Situation	**On-Campus**	**25**	**4.12 (1.03)**	**3.62 * (1.07)**	**4.23 (0.98)**	**3.96 * (1.03)**	**3.25 * (1.20)**	**4.43 (0.83)**
	Off-Campus Alone	**30**	**3.49 * (1.36)**	**3.46 * (1.21)**	**3.84 * (1.29)**	**3.77 * (1.17)**	**3.28 * (1.35)**	**4.10 (1.19)**
	Off-Campus with Friends / Roommates	**43**	**3.56 * (1.33)**	**3.61 * (1.21)**	**4.12 (1.14)**	**3.81 * (1.12)**	**3.24 * (1.12)**	**4.05 (1.26)**
	Off-Campus with Family	**287**	**3.42 * (1.23)**	**3.65 * (1.12)**	**4.06 (1.06)**	**3.86 * (1.10)**	**3.39 * (1.18)**	**4.13 (1.05)**
	No Stable Housing	**4**	**2.81 ** (1.69)**	**3.38 * (1.23)**	**2.46 ** (1.57)**	**2.93 ** (1.83)**	**2.69 ** (1.28)**	**3.00 * (1.70)**
Commuting Frequency	**Rarely / Never**	**53**	**3.31 * (1.41)**	**3.67 * (1.12)**	**4.14 (1.06)**	**4.01 (1.01)**	**3.63 * (1.11)**	**4.15 (1.08)**
	1-2 days/wk	**109**	**3.48 * (1.21)**	**3.66 * (1.08)**	**4.12 (0.99)**	**3.88 * (1.05)**	**3.38 * (1.23)**	**4.09 (1.13)**
	3-4 days/wk	**162**	**3.46 * (1.20)**	**3.60 * (1.13)**	**4.01 (1.14)**	**3.83 * (1.13)**	**3.34 * (1.11)**	**4.14 (1.05)**
	5 + days/wk	**74**	**3.63 * (1.32)**	**3.58 * (1.22)**	**3.98 * (1.16)**	**3.77 * (1.21)**	**3.18 * (1.29)**	**4.19 (1.08)**

[+] Minimum of the sample sizes of each of the six constructs

Mean Values: * 3.0 < Mean < 4.0 ** Mean < 3.0

Mean (standard deviation) for constructs within student populations *(Likert Scale from 1-5, where 5 is the most positive response)*			Class-room Comfort	Faculty Under-standing	Belong-ingness	Thriving	Mindful-ness	Motiv-ation
Independent Variable	***Variable Categories***	***'n'*** [+]						
Employment Situation	**Work 40 + hrs/wk**	**43**	**3.72 * (1.40)**	**3.76 * (1.18)**	**4.19 (1.20)**	**4.07 (1.06)**	**3.61 * (1.30)**	**4.31 (1.04)**
	Work 30-40 hrs/wk	**21**	**3.60 * (0.99)**	**3.65 * (1.02)**	**4.20 (0.82)**	**4.17 (0.75)**	**3.31 * (1.10)**	**4.25 (0.97)**
	Work 20-30 hrs/wk	**49**	**3.56 * (1.23)**	**3.66 * (1.19)**	**3.94 * (1.07)**	**3.73 * (1.11)**	**3.12 * (1.17)**	**4.16 (1.01)**
	Work 10-20 hrs/wk	**74**	**3.49 * (1.25)**	**3.83 * (1.04)**	**4.20 (1.00)**	**4.03 (1.03)**	**3.35 * (1.18)**	**4.31 (0.88)**
	Work < 10 hrs/wk	**30**	**3.44 * (1.41)**	**3.59 * (1.07)**	**4.32 (0.84)**	**3.98 * (1.05)**	**3.55 * (0.97)**	**4.22 (0.91)**
	Not Employed	**181**	**3.37 * (1.23)**	**3.49 * (1.15)**	**3.92 * (1.15)**	**3.71 * (1.17)**	**3.34 * (1.19)**	**3.99 * (1.21)**
Legal Status	**U.S. Citizen / P.R.**	**355**	**3.45 * (1.26)**	**3.62 * (1.22)**	**4.05 (1.10)**	**3.87 * (1.10)**	**3.35 * (1.19)**	**4.15 (1.08)**
	International Student	**17**	**4.00 (0.98)**	**3.78 * (1.01)**	**4.16 (0.96)**	**3.89 * (0.99)**	**3.49 * (1.01)**	**4.15 (0.89)**
	Undocumented / DACA Recipient	**19**	**3.40 * (1.27)**	**3.54 * (1.35)**	**4.06 (1.11)**	**3.47 * (1.28)**	**3.26 * (1.19)**	**3.99 * (1.28)**
Gender	**Man**	**139**	**3.64 * (1.26)**	**3.73 * (1.17)**	**4.18 (1.10)**	**3.91 * (1.17)**	**3.41 * (1.23)**	**4.23 (1.10)**
	Woman	**238**	**3.38 * (1.25)**	**3.56 * (1.12)**	**4.02 (1.07)**	**3.88 * (1.05)**	**3.35 * (1.15)**	**4.13 (1.05)**
	Non-Binary	**10**	**3.43 * (1.04)**	**3.53 * (0.88)**	**3.41 * (1.38)**	**3.05 * (1.22)**	**3.00 * (1.19)**	**3.45 * (1.40)**
Race / Ethnicity	**African American / Black**	**12**	**3.60 * (1.42)**	**3.92 * (0.96)**	**4.19 (0.92)**	**4.22 (0.73)**	**3.31 * (1.07)**	**4.48 (0.80)**
	Asian / Asian American	**78**	**3.47 * (1.26)**	**3.46 * (1.12)**	**3.78 * (1.19)**	**3.61 * (1.26)**	**3.18 * (1.21)**	**3.86 * (1.20)**
	Hispanic / Latinx	**223**	**3.42 * (1.24)**	**3.63 * (1.13)**	**4.09 (1.05)**	**3.89 * (1.08)**	**3.41 * (1.19)**	**4.15 (1.04)**
	White	**28**	**3.96 * (1.26)**	**3.99 * (1.12)**	**4.55 (0.89)**	**4.24 (0.84)**	**3.60 * (1.06)**	**4.50 (1.03)**
	Multiracial / Multiethnic	**36**	**3.35 * (1.24)**	**3.51 * (1.05)**	**4.05 (1.04)**	**3.68 * (1.08)**	**3.13 * (1.19)**	**4.24 (1.06)**
	LGBTQIA+	**74**	**3.51 * (1.26)**	**3.55 * (1.18)**	**4.12 (1.07)**	**3.54 * (1.21)**	**2.90 ** (1.14)**	**4.26 (1.01)**
	Not LGBTQIA+	**294**	**3.49 * (1.26)**	**3.67 * (1.10)**	**4.08 (1.09)**	**3.99 * (1.05)**	**3.51 * (1.14)**	**4.16 (1.08)**

[+] Minimum of the sample sizes of each of the six constructs

Mean Values: * 3.0 < Mean < 4.0 ** Mean < 3.0

Mean (standard deviation) for constructs within student populations (Likert Scale from 1-5, with 5 is most positive response)			Class-room Comfort	Faculty Under-standing	Belong-ingness	Thriving	Mindful-ness	Motiv-ation
Independent Variable	*Variable Categories*	*'n'* [+]						
Annual Household Income	> $100,000 /yr	18	3.83 * (1.34)	4.22 (0.97)	4.46 (0.82)	4.12 (1.16)	3.66 * (1.01)	4.38 (1.01)
	$75,000 - $100,000 /yr	26	3.56 * (1.16)	3.75 * (1.01)	4.15 (1.06)	4.09 (1.11)	3.42 * (1.33)	4.08 (1.22)
	$50,000 - $75,000 /yr	35	3.50 * (1.18)	3.67 * (0.99)	4.25 (0.87)	3.89 * (1.04)	3.42 * (1.21)	4.36 (0.94)
	$25,000 - $50,000 /yr	85	3.49 * (1.28)	3.70 * (1.12)	3.94 * (1.13)	3.79 * (1.13)	3.32 * (1.21)	4.06 (1.14)
	< $25,000 /yr	148	3.46 * (1.27)	3.53 * (1.14)	4.07 (1.13)	3.88 * (1.09)	3.32 * (1.19)	4.17 (1.06)
	With Disabilities	55	3.52 * (1.40)	3.63 * (1.12)	3.93 * (1.12)	3.59 * (1.24)	3.37 * (1.25)	3.94 * (1.13)
	Without Disabilities	313	3.50 * (1.23)	3.64 * (1.12)	4.12 (1.07)	3.94 * (1.08)	3.38 * (1.18)	4.18 (1.08)
	Veteran	7	3.13 * (1.29)	3.00 * (1.40)	3.33 * (1.49)	3.76 * (1.29)	3.09 * (1.25)	3.19 * (1.65)
	Non-Veteran	390	3.48 * (1.25)	3.63 * (1.12)	4.06 (1.08)	3.86 * (1.11)	3.36 * (1.18)	4.16 (1.07)
Number of Languages Fluently Spoken	1	111	3.44 * (1.28)	3.71 * (1.07)	4.06 (1.07)	3.84 * (1.06)	3.30 * (1.15)	4.12 (1.10)
	2	260	3.46 * (1.26)	3.57 * (1.17)	4.05 (1.11)	3.85 * (1.14)	3.39 * (1.20)	4.16 (1.09)
	3+	27	3.73 * (1.08)	3.68 * (0.99)	4.00 (1.06)	3.95 * (1.05)	3.30 * (1.24)	4.00 (0.94)
Undergraduate Degree (For Graduate Students)	From Cal State LA	19	3.55 * (1.20)	3.68 * (1.27)	4.21 (1.11)	3.66 * (1.47)	3.26 * (1.34)	4.10 (1.39)
	Not from Cal State LA	44	3.81 * (1.20)	3.70 * (1.14)	4.25 (1.13)	3.97 * (1.06)	3.47 * (1.06)	4.33 (0.87)
Graduate Program (For Graduate Students)	[name of engineering college redacted]	23	3.57 * (1.18)	3.40 * (1.27)	4.04 (1.19)	3.41 * (1.32)	3.28 * (1.16)	3.96 * (1.02)
	[name of science college redacted]	23	3.72 * (1.27)	3.91 * (0.99)	4.36 (0.99)	4.09 (1.00)	3.46 * (1.19)	4.48 (0.97)
	Social Science	15	3.98 * (1.08)	3.93 * (1.26)	4.37 (1.13)	4.11 (1.16)	3.40 * (1.10)	4.32 (1.17)
Entry Mechanism (For Undergraduate Students)	Freshman	179	3.39 * (1.23)	3.56 * (1.12)	3.96 * (1.06)	3.78 * (1.13)	3.28 * (1.21)	4.04 (1.07)
	Transfer	152	3.45 * (1.31)	3.65 * (1.12)	4.08 (1.12)	3.94 * (1.04)	3.44 * (1.17)	4.21 (1.09)

[+] Minimum of the sample sizes of each of the six constructs

Mean Values: * 3.0 < Mean < 4.0 ** Mean < 3.0

Mean (standard deviation) for constructs within student populations (Likert Scale from 1-5, with 5 is most positive response)			Class-room Comfort	Faculty Under-standing	Belong-ingness	Thriving	Mindful-ness	Motiv-ation
Independent Variable	***Variable Categories***	***'n'*** [+]						
Undergraduate Program (For Undergraduate Students)	**[name of engineering college redacted]**	**95**	**3.54 * (1.20)**	**3.51 * (1.13)**	**3.98 * (1.14)**	**3.90 * (1.08)**	**3.28 * (1.15)**	**4.15 (1.10)**
	Natural Science	**91**	**3.43 * (1.29)**	**3.54 * (1.19)**	**3.85 * (1.15)**	**3.76 * (1.18)**	**3.23 * (1.26)**	**4.13 (1.06)**
	Social Science	**136**	**3.34 * (1.28)**	**3.73 * (1.06)**	**4.13 (0.99)**	**3.87 * (1.03)**	**3.46 * (1.19)**	**4.08 (1.10)**
Commute Length (For Students Living Off-Campus)	**< 30 mins**	**142**	**3.42 * (1.22)**	**3.65 * (1.09)**	**4.06 (1.04)**	**3.84 * (1.10)**	**3.32 * (1.19)**	**4.04 (1.12)**
	30 mins – 1 hr	**152**	**3.31 * (1.29)**	**3.52 * (1.16)**	**4.04 (1.07)**	**3.87 * (1.10)**	**3.39 * (1.18)**	**4.18 (1.03)**
	> 1 hr	**74**	**3.63 * (1.25)**	**3.73 * (1.17)**	**3.95 * (1.28)**	**3.78 * (1.22)**	**3.35 * (1.19)**	**4.11 (1.20)**
Living Situation (For Students Living Off-Campus with Family Members)	**With Parents / Guardians**	**256**	**3.37 * (1.24)**	**3.64 * (1.12)**	**4.03 (1.07)**	**3.83 * (1.12)**	**3.35 * (1.20)**	**4.11 (1.06)**
	Not With Parents / Guardians	**29**	**3.79 * (1.08)**	**3.68 * (1.11)**	**4.32 (0.96)**	**4.18 (0.85)**	**3.71 * (0.94)**	**4.31 (1.02)**
Childcare Responsibilities (For Students Living Off-Campus with Family Members)	**Has Childcare Responsibilities**	**79**	**3.48 * (1.20)**	**3.69 * (1.18)**	**4.12 (0.93)**	**3.86 * (1.08)**	**3.28 * (1.27)**	**4.13 (1.07)**
	Does Not Have Childcare Responsibilities	**206**	**3.38 * (1.24)**	**3.63 * (1.10)**	**4.03 (1.10)**	**3.87 * (1.11)**	**3.43 * (1.14)**	**4.13 (1.05)**

[+] Minimum of the sample sizes of each of the six constructs

Mean Values: * 3.0 < Mean < 4.0 ** Mean < 3.0

Table 3: Statistical significance of baseline EEHS results

p-values for Constructs Across Various Considerations	Classroom Comfort	Faculty Under-standing	Belong-ingness	Thriving	Mindful-ness	Motivation
Undergraduate vs. Graduate	**0.066 *** • Lower for undergrad-uate students	**0.472**	**0.024 *** • Lower for undergrad-uate students	**0.842**	**0.706**	**0.304**
Full-Time vs. Part-Time	**1.000**	**0.456**	**0.948**	**0.949**	**0.301**	**0.741**
Year in Program	**0.744**	**0.866**	**0.942**	**0.977**	**0.802**	**0.691**
First-Gen vs. Non-First-Gen	**0.885**	**0.547**	**0.938**	**0.491**	**0.274**	**0.813**
Living / Housing Situation	**0.066 *** • Higher for students who live in on-campus housing • Lower for students with no stable living situation	**0.914**	**0.034 *** • Lower for students who live alone off-campus and students with no stable living situation	**0.523**	**0.695**	**0.158**
Commuting Frequency	**0.555**	**0.943**	**0.719**	**0.652**	**0.200**	**0.939**
Employment Situation	**0.630**	**0.328**	**0.185**	**0.095 *** • Lower for students who work less hours per week	**0.409**	**0.230**
Legal Status	**0.185**	**0.820**	**0.917**	**0.304**	**0.836**	**0.813**
Gender	**0.147**	**0.359**	**0.053 *** • Higher for men • Lower for non-binary students	**0.044 *** • Higher for men • Lower for non-binary students	**0.525**	**0.066 *** • Higher for men • Lower for non-binary students
Race / Ethnicity	**0.263**	**0.206**	**0.019 *** • Higher for white students • Lower for Asian / Asian-American students	**0.043 *** • Higher for African American / Black and white students • Lower for Asian / Asian-American and multiracial / multi-ethnic students	**0.312**	**0.038 *** • Higher for African American / Black and white students • Lower for Asian / Asian-American students

Statistical Significance: * $p < 0.1$ ** $p < 0.01$

p-values for Constructs Across Various Considerations	Classroom Comfort	Faculty Under-standing	Belong-ingness	Thriving	Mindful-ness	Motivation
LGBTQIA+ vs. Non-LGBTQIA+	**0.903**	**0.406**	**0.777**	**0.002 **** • Lower for LGBTQIA+ students	**< 0.0001 **** • Lower for LGBTQIA + students	**0.471**
Annual Household Income	**0.834**	**0.138**	**0.313**	**0.657**	**0.807**	**0.568**
With Disabilities vs. Without Disabilities	**0.913**	**0.951**	**0.222**	**0.031 *** • Lower for students with disabilities	**0.954**	**0.129**
Veteran vs. Non-Veteran	**0.434**	**0.118**	**0.079 *** • Lower for veteran students	**0.802**	**0.523**	**0.013 *** • Lower for veteran students
Number of Languages Fluently Spoken	**0.528**	**0.526**	**0.967**	**0.895**	**0.770**	**0.743**
Undergraduate Degree from Cal State LA vs. Not From Cal State LA (For Graduate Students)	**0.423**	**0.950**	**0.897**	**0.340**	**0.500**	**0.420**
Graduate Program (For Graduate Students)	**0.588**	**0.253**	**0.543**	**0.089 *** • Lower for graduate students in the College of Engineering, Computer Science, and Technology	**0.865**	**0.228**
Entry Mechanism (For Undergraduate Students)	**0.667**	**0.466**	**0.318**	**0.187**	**0.221**	**0.152**
Undergraduate Program (For Undergraduate Students)	**0.487**	**0.255**	**0.153**	**0.650**	**0.297**	**0.877**
Commute Length (For Students Living Off-Campus)	**0.195**	**0.375**	**0.776**	**0.853**	**0.877**	**0.547**
Living Situation (For Students Living Off-Campus with Family Members)	**0.076 *** • Lower for students who live with parents / guardians	**0.853**	**0.163**	**0.104**	**0.114**	**0.327**
Childcare Responsibilities (For Students Living Off-Campus with Family Members)	**0.536**	**0.685**	**0.519**	**0.945**	**0.332**	**1.000**

Statistical Significance: * $p < 0.1$ ** $p < 0.01$

Classroom comfort

Classroom comfort is lacking (defined as mean values of less than 4.0) for all student groups queried, except those who live on campus and international students. It is particularly lacking (mean value less than 3.0) for students who do not have access to stable housing, with a mean value of 2.81. Classroom comfort is higher for students who live in on-campus housing and much lower for students with no stable living situation, with $p = 0.066$. It is also lower for students who live with the person or people who raised them than for those who live with other family members, with $p = 0.076$.

Reported levels of classroom comfort increase monotonically with increasing numbers of hours worked and are lowest for students who are not employed. Classroom comfort levels also increase with increasing number of days on campus weekly. Finally, classroom comfort is lower for undergraduate students than graduate students, with $p = 0.07$.

Faculty understanding

Faculty understanding is lacking for all student groups queried, with the single exception of those from households with incomes above $100,000 per year.

Belongingness

Belongingness is lacking for many student groups queried. Students who live off-campus alone report low levels of belongingness, and levels are particularly lacking for students who do not have stable housing, with an extremely low mean value of 2.46. Levels of belonging are dependent on student living situation with $p = 0.034$.

Belongingness is lacking for undergraduate students as a whole; belongingness is higher for graduate students, with $p = 0.024$. It is also lacking for women, and lowest by far for non-binary students, with $p = 0.053$. Belongingness is highest for white students and lowest for Asian / Asian-American students and is dependent on race/ethnicity with $p = 0.019$. It is also lower for veteran students than non-veterans, with $p = 0.079$. Belongingness also decreases with increasing number of days on campus per week, with students who come to campus 5 or more days per week reporting the lowest levels of belonging. Other groups in which students report low levels of belongingness include: students in the 2nd and 3rd years of their programs, students who work 20 to 30 hours per week or are not employed, students from households with incomes between $25,000 and $50,000 per year, students with disabilities, students who entered the university as freshmen (rather than as transfers), students with commute times longer than an hour, and undergraduate students pursuing programs in the College of Engineering, Computer Science, and Technology or the natural science departments within the College of Natural and Social Sciences.

Thriving

Thriving is lacking for nearly all student groups queried. Students who rarely or never come to campus report higher levels of thriving than those who come to campus regularly, and levels of thriving decrease with increased frequency of commuting. In general, thriving is typically lower for students who worked less hours per week, with $p = 0.095$; those students who work 30 or

more hours per week or 10 to 20 hours per week report higher levels of thriving. Thriving is highest for students who are white or African American / Black and lowest for Asian / Asian-American and multiracial/ethnic students, with $p = 0.043$ for racial/ethnic differences. Levels of thriving are highest for students who live off-campus with family members who are not their parents or guardians and particularly lacking for students who do not have stable housing, the latter of whom report a mean value of thriving of 2.93. Thriving is also lower for women than men, and lowest by far for non-binary students, with $p = 0.044$. It is also lower for LGBTQIA+ students, with $p = 0.002$, lower for students with disabilities, with $p = 0.031$, and lower for graduate students in the College of Engineering, Computer Science, and Technology than those in the College of Natural and Social Sciences, with $p = 0.089$. Finally, thriving is lacking for students from households with incomes less than $75,000 per year, who constitute more than 85% of the survey participants.

Mindfulness

Mindfulness is lacking for all student groups queried. It is particularly lacking for students who do not have stable housing (mean value: 2.69) and LGBTQIA+ students (mean value: 2.90). The dependence of mindfulness on LGBTQIA+ status is statistically significant, with $p < 0.0001$. Mindfulness also decreases with increasing number of days on campus per week.

Motivation

Motivation is lacking for several student groups queried. It is lower for women than men, and lowest by far for non-binary students, with $p = 0.066$. It is highest for white and African American / Black students and lowest for Asian / Asian-American students, with $p = 0.038$. It is also lower for veteran students than non-veterans, with $p = 0.013$. Motivation is additionally lacking for the following student groups: students in their 6^{th} year or more of their programs, students who do not have stable housing, students who are not employed, students who are undocumented or Deferred Action for Childhood Arrival (DACA) recipients, students with disabilities, and graduate students in the College of Engineering, Computer Science, and Technology.

Overall Ecosystem Health

In querying the varying experiences of different groups of students, we find no notable differences between the levels of ecosystem health reported by full-time and part-time students, first-generation and non-first-generation students, students who live off-campus with family members and students who live off-campus with roommates, students who live off-campus with family members regardless of whether or not they have regular childcare responsibilities, students who speak various numbers of languages, and graduate students in natural science and social science programs within the College of Natural and Social Sciences.

The lack of difference in response to ecosystem health measures between first-generation and non-first-generation students is particularly surprising given previous findings of research in this area [20-22]. This result may be due to an element of confusion over the definition of "first generation". While the most common definition of the term was provided to students when they responded to the corresponding demographic item of the survey (a "first-gen" student, by the

federal definition, is a student without a parent who received at least a 4-year college degree) [23], the California State University system utilizes a different definition in their institutional records: students with a parent who has attended "some college", regardless of degree status, are not defined as first-generation [4]. As more than 80% of Cal State LA undergraduates lack a parent with at least a 4-year degree but more than 20% of these students do have a parent who has attended college [4], it is possible that students may be being presented with conflicting determinations of their first-generation-student status, potentially causing confusion. Future work in this area should designate between 1) students with a parent with at least a 4-year degree, 2) students with parents who lack a 4-year degree but have attended some college, and 3) students whose parents have no college experience whatsoever.

On the other hand, several notable differences in overall ecosystem health by demographic are also observed. Graduate students report higher levels of ecosystem health than undergraduate students in all aspects of ecosystem health. This is perhaps unsurprising, as these students have all successfully completed undergraduate study. Within the graduate student population, however, students in the College of Engineering, Computer Science, and Technology report lower levels of ecosystem health than those in the College of Natural and Social Sciences. Graduate students who completed their undergraduate degrees at Cal State LA report lower levels of ecosystem health from those with undergraduate degrees from elsewhere. Interestingly, within the undergraduate student population, students who started at Cal State LA as freshmen report lower levels of ecosystem health than those who transferred.

Students who reside off-campus and live with the person or people who raised them report lower levels of ecosystem health than those who live off-campus with other family members. Students without stable housing report lower levels of ecosystem health than those with stable housing, regardless of the housing situation. However, we have very low 'n'-values (only 4 students) who reported unstable housing. On the other hand, 44 students chose "Prefer not to say" when asked about their living/housing situation (an option that was given for many of the demographic items), and it seems plausible that many housing-insecure students may have selected this option. It is not possible to calculate the statistical power of our result, because the number of students who experience housing insecurity at Cal State LA is unknown and likely fluctuates rapidly. Significantly more research and advocacy are required to understand and contend with the housing crisis facing students in Los Angeles.

Measures of ecosystem health are generally lowest for DACA/undocumented students (with the single exception of belongingness, which is similar to that of US citizens/permanent residents) and highest for international students. The financial situation of the household also appears to be impactful; reported levels of ecosystem health are always highest for the highest income group and generally decrease with decreasing income. Men report the highest levels of ecosystem health, and non-binary students generally report the lowest levels (with the exception of classroom comfort, which is lowest for women). White students report the highest levels of ecosystem health of every racial/ethnic group in every aspect of ecosystem health, whereas Asian / Asian-American and multiracial/multiethnic students generally report the lowest levels. Veteran students also report lower levels of ecosystem health.

Conclusion

The first administration of the EEHS provides findings that conclude generally low levels of ecosystem health for students in STEM higher educational programs at California State University, Los Angeles. Particularly notable and problematic results include the poor levels of ecosystem health reported by students without access to stable housing as well as poor thriving and mindfulness of students who identify as LGBTQIA+. Future work must better address the needs of these students, in terms of both research as well as structural advocacy. The results will also be used to inform the content and approach of the Eco-STEM Communities of Practice, as these efforts comprise the theory of change of the project. Over time, results from future iterations of the EEHS will provide insight into whether the changing mental models of faculty are producing any impact on students' perceptions of the health of the STEM educational ecosystem.

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References

[1] Office of Communications and Public Affairs and Office of Institutional Effectiveness, "Cal State LA: Facts," California State University, Los Angeles, 2022. Available: https://www.calstatela.edu/sites/default/files/groups/Institutional%20Research/pdf/fact63_accessible.pdf (accessed: Apr. 1, 2023).

[2] U.S. News and World Report, "California State University--Los Angeles Student Life," U.S. News and World Report L.P., 2023, Available: https://www.usnews.com/best-colleges/california-state-university-los-angeles-1140/student-life#:~:text=California%20State%20University%2D%2DLos%20Angeles%20has%20a%20total%20undergraduate,of%20students%20live%20off%20campus (accessed: Apr. 1, 2023).

[3] The New York Times, "Economic diversity and student outcomes at California State University, Los Angeles," The New York Times Company, 2017. Available: https://www.nytimes.com/interactive/projects/college-mobility/california-state-university-los-angeles#:~:text=The%20median%20family%20income%20of,but%20became%20a%20rich%20adult (accessed: Apr. 1, 2023).

[4] Office of Institutional Effectiveness, "Student Enrollment," California State University, Los Angeles, 2022. Available: https://www.calstatela.edu/InstitutionalEffectiveness/student-enrollment (accessed: Feb. 3, 2022).

[5] T. Molle, "CSU to Roll out Delivery of Immigration Legal Services for Students and Employees." The California State University, 2019. Available: https://www.calstate.edu/csu-system/news/Pages/California-State-University-to-RollOut-Delivery-of-Immigration-Legal-Services-for-Students-and-Employees.aspx (accessed Feb. 3, 2022).

[6] R. M. Crutchfield and J. Maguire, "Study of student service access and basic needs," California State University Office of the Chancellor, April 2019.

[7] G. B. Menezes, C. L. Bowen, J. Dong, N. Warter-Perez, L. L. Thompson, S. Heubach, D. Galván, J. G. Mijares, and E. Schiorring, "Eco-STEM: Transforming STEM Education using an Asset-based Ecosystem Model," in ASEE Annual Conference and Exposition, 2022.

[8] P. Freire and M.B. Ramos (translator), Pedagogy of the Oppressed, 1970, Herder and Herder, New York, NY.

[9] N. Warter-Perez, C. L. Bowen, J. G. Mijares, D. Galván, L. L. Thompson, and G. B. Menezes, "Work In Progress: Developing a Faculty Community of Practice to Support a Healthy Educational Ecosystem," in ASEE Annual Conference and Exposition, 2022.

[10] C. Restrepo Nazar, L. L. Thompson, C. L. Bowen, and G. B. Menezes, "Work in Progress: Developing a Leadership Community of Practice Towards a Healthy Educational Ecosystem," in ASEE Annual Conference and Exposition, 2023.

[11] C. L. Bowen, L. L. Thompson, G. B. Menezes, and C. Restrepo Nazar, "Work-In-Progress: Measuring Systemic Educational Wellness using the Eco-STEM Educational Ecosystem Health Survey," in 2022 ASEE Annual Conference & Exposition Proceedings, 2022.

[12] M. Hoffman, J. Richmond, J. Morrow, and K. Salomone, "Investigating 'Sense of Belonging' in First-Year College Students," J. Coll. Student Retent. Res. Theory Pract., vol. 4, no. 3, pp. 227–256, 2002, doi: 10.2190/dryc-cxq9-jq8v-ht4v.

[13] M. Scheidt et al., "Validity evidence for the SUCCESS survey: Measuring non-cognitive and affective traits of engineering and computing students," ASEE Annu. Conf. Expo. Conf. Proc., vol. 2018-June, 2018.

[14] T. F. Smith, D. Wilson, D. C. Jones, M. Plett, R. A. Bates, and N. M. Veilleux, "Investigation of belonging for engineering and science undergraduates by year in school," ASEE Annu. Conf. Expo. Conf. Proc., 2012, doi: 10.18260/1-2--21615.

[15] D. Anderson-Butcher and D. E. Conroy, "Factorial and criterion validity of scores of a measure of belonging in youth development programs," Educ. Psychol. Meas., vol. 62, no. 5, pp. 857–876, 2002, doi: 10.1177/001316402236882.

[16] J. W. Lounsbury and D. DeNeui, "Collegiate psychological sense of community in relation to size of college/university and extroversion," J. Community Psychol., vol. 24, no. 4, pp. 381–394, 1996, doi: 10.1002/(SICI)1520-6629(199610)24:4<381::AIDJCOP7>3.0.CO;2-X.

[17] R. Su, L. Tay, and E. Diener, "The Development and Validation of the Comprehensive Inventory of Thriving (CIT) and the Brief Inventory of Thriving (BIT)," Appl. Psychol. Heal. Well-Being, vol. 6, no. 3, pp. 251–279, 2014, doi: 10.1111/aphw.12027.

[18] B. Rieken, M. Schar, S. Shapiro, S. K. Gilmartin, and S. Sheppard, "Exploring the relationship between mindfulness and innovation in engineering students," ASEE Annu. Conf. Expo. Conf. Proc., vol. 2017-June, 2017, doi: 10.18260/1-2--28341.

[19] K. W. Brown and R. M. Ryan, "The Benefits of Being Present: Mindfulness and Its Role in Psychological Well-Being," J. Pers. Soc. Psychol., vol. 84, no. 4, pp. 822–848, 2003, doi: 10.1037/0022-3514.84.4.822.

[20] L. Horn, L., and L. K. Kojaku, "High school academic curriculum and the persistence path through college: Persistence and transfer behavior of undergraduates 3 years after entering 4-year institutions," Edu. Stat. Qtrly., vol. 3, no. 3, pp.65-72, 2001.

[21] A. M. Nunez and S. Cuccaro-Alamin, "First-generation students: Undergraduates whose parent never enrolled in postsecondary education (NCES 1999-082)," Washington, DC: U.S. Government Printing Office, 1998.

[22] R. J. Riehl, R. J., "The academic preparation, aspirations, and first-year performance of first-generation students," College and University, vol. 70, no. 1, pp. 14-19, 1994.

[23] U.S. Department of Education, "Higher Education Act - Federal TRIO Programs," https://www2.ed.gov/about/offices/list/ope/trio/triohea.pdf (accessed 28 Feb., 2023).