Quantitative Evaluation of the EPIC Program: Measuring Gains in Engineering Confidence and Interest Across Socioeconomic and Challenge-Based Backgrounds (RTP)

Alejandra Zuniga, California Polytechnic State University, San Luis Obispo
Cristina Rashell Ruiz, California Polytechnic State University, San Luis Obispo
Maria Manzano, California Polytechnic State University, San Luis Obispo

Maria Manzano is the Director of Engineering Special Programs and EPIC program, where she works to develop programs to reach out to pre-college students to encourage them to pursue engineering in college. She is involved with a variety of diversity and in

Dr. Bridget Benson, California Polytechnic State University, San Luis Obispo

Bridget Benson received a Bachelor's degree in Computer Engineering at California Polytechnic State University San Luis Obipso in 2005, a Master's degree in Electrical and Computer Engineering at the University of California Santa Barbara in 2007 and a PhD at the University of California San Diego in 2010. Dr. Benson's research interests span engineering education with an emphasis on inclusive teaching practices.

Dr. Zoe Wood Wood, California Polytechnic State University, San Luis Obispo

Whether it is creating computer graphics models of underwater shipwrecks or using art and creativity to help students learn computational thinking, Professor Zoe Wood's projects unite visual arts, mathematics and computer science.

Quantitative Evaluation of the EPIC Program: Measuring Gains in Engineering Confidence and Interest Across Socioeconomic and Challenge-Based Backgrounds (RTP)

Alejandra Zuñiga, Cristina Ruiz, Maria Manzano, Dr. Bridget Benson, Dr. Zoë Wood
College of Engineering, California Polytechnic State University San Luis Obispo

Introduction

Despite sustained national attention, engineering education continues to face persistent inequities in participation and representation. Women, students from historically marginalized racial and ethnic groups, and students from lower socioeconomic backgrounds remain underrepresented in engineering degree programs and the engineering workforce [1], [2]. These disparities are not explained by differences in ability, but rather by unequal access to early exposure, educational resources, role models, and opportunities to develop interest, confidence, and identity in engineering prior to college [3] – [6].

A growing body of research demonstrates that interest in engineering develops early and is a strong predictor of later academic and career pathways, often emerging during late elementary, middle, or early high school years [7] – [9]. However, engineering remains largely absent from formal K–12 curricula, particularly in schools serving low-income or marginalized communities [10], [11]. As a result, many students, especially those from underserved backgrounds, enter high school or make postsecondary decisions without meaningful exposure to engineering as a field of study or career option [12], [13].

Informal engineering learning environments, including summer camps, outreach programs, and residential experiences, have emerged as a critical response to these structural gaps. Prior research indicates that hands-on, project-based informal engineering experiences can positively influence students' engineering interest, self-efficacy, and identity formation, particularly when experiences are immersive and intentionally designed [14] – [18]. Engineering summer camps offer students opportunities to engage in authentic engineering practices, collaborate with peers, interact with mentors, and begin to envision themselves as future engineers [16], [19].

Multi-method studies of engineering summer camps have documented increases in engineering interest and identity following participation, with especially strong effects observed among middle school students, a critical developmental period for career exploration [16], [20]. Robinson et al. found that structured, purposefully designed engineering camps supported both situational interest and emerging individual interest, as well as engineering identity development [16]. Complementary work by Kirn, Godwin, and colleagues emphasizes the role of recognition, competence, and interest as interconnected components of engineering identity that can be cultivated through informal learning contexts [21], [22].

Socioeconomic context further shapes students' access to engineering pathways. Major's work highlights that socioeconomic inequality in engineering education extends beyond income alone, encompassing access to educational resources, early exposure opportunities, and interpersonal support structures that intersect with race, class, and geography [23], [24]. Students facing greater structural barriers often report lower confidence and fewer opportunities to engage with engineering prior to college [24], [25]. Despite this, relatively few program evaluations explicitly examine how informal engineering experiences differentially impact students based on cumulative challenge or socioeconomic context.

This paper contributes to the pre-college engineering education literature by presenting an evaluation of EPIC (Engineering Possibilities In College), a residential, university-based engineering outreach program. Building on prior scholarship on informal engineering education, engineering identity, and socioeconomic inequality, this evaluation examines changes in student interest and confidence following participation in EPIC, with particular attention to challenge-based and socioeconomic contextual factors.

Program Description

Engineering Possibilities in College (EPIC) is a university-based pre-college engineering outreach program housed within the College of Engineering at California Polytechnic State University San Luis Obispo (Cal Poly). EPIC aligns with the Cal Poly's "learn-by-doing" motto and has been used as a laboratory for engineering education research [26-28]. As one of the college's flagship outreach initiatives, EPIC seeks to support students' early exploration of engineering disciplines while fostering a sense of belonging within an engineering-focused academic community.

Program History and Structure

EPIC began in 2007 as a half-day summer program serving 20 middle and high school female students. Since its inception, the program has expanded substantially in scope and scale. As of 2025, EPIC offers up to six summer sessions annually, serving more than 800 middle and high school students. Sessions are offered separately for middle school (rising 7-9th grades) and high school (rising 10–12th grades) participants, with content tailored to students' developmental stage and prior exposure to STEM.

Sessions are offered in a residential format (a virtual format was offered during COVID). Residential sessions allow participants to live in university housing and engage fully in campus life, providing many students, particularly those without prior exposure to higher education, with an immersive collegiate experience designed to support envisioning themselves as future college students.

Instructional Design and Learning Experience
EPIC emphasizes experiential, project-based learning consistent with the institution's learn-by-doing motto. Participants engage in hands-on engineering laboratories led by university faculty, staff, and industry professionals. Across sessions, students are introduced to multiple engineering disciplines and participate in activities requiring them to design, build, test, and iterate on engineering solutions. Each session culminates in a collaborative engineering group project intended to reinforce teamwork, problem-solving, and applied engineering thinking.

In addition to technical instruction, EPIC includes a structured speaker series featuring college admissions representatives, engineering faculty, industry professionals, and current engineering students. These sessions are designed to demystify engineering pathways, expose students to diverse role models, and provide insight into engineering majors, college life, and career trajectories.

Community-Building and Co-Curricular Activities
EPIC intentionally integrates social and recreational activities to promote peer connection and community building. Participants engage in structured events such as swimming, bowling, movie nights, hiking, and field games, as well as guided campus and College of Engineering tours. These experiences are designed to reduce anxiety associated with unfamiliar academic environments and to strengthen participants' identification with the engineering community.

Admissions, Cost, and Access
Admission to EPIC is competitive and based on a holistic review process that includes a written essay, demonstrated interest in engineering, academic preparation, and extracurricular engagement. Program administrators aim to identify students who are likely to benefit most from the experience, particularly those with strong interest but limited prior exposure.

In 2025, the program registration fee was $1,900 per participant for Session 1 (rising 7–9th grades) and $2,100 per participant for Sessions 2–4 (rising 10-12th grades). These fees encompassed all programmatic components, including instructional activities, classroom materials, evening programming, educational tours, and invited speakers.

During the 2025 program year, EPIC served a total of 715 participants. Of these, at least 42% received either full or partial financial support in the form of scholarships. The total amount awarded in scholarships was $544,600. EPIC directly funded $171,600 of this total, while the remaining $373,000 was supported through external partnerships with programs and school districts, including Cal Poly President's Office, The Wonderful Company, Grown Academy, ACE Mentor, Santa Maria Joint Union High School, Migrant Education Program Region XXII, Guadalupe School District, Salinas Unified High School District, Granite Construction, and KIPP Southern California.

Scholarship awards were allocated based on demonstrated financial need. Individual scholarship amounts ranged from $300 to $2,100 (the full program registration fee).

EPIC engages in active outreach to numerous educational organizations to promote equitable access to the program. For example, the program has a historically strong relationship with the Migrant Education Program (MEP), which is intended to assist students whose families must relocate often for jobs in the agricultural, dairy, lumber, and fishing industries. To be eligible, a student's family must have moved at least once in the previous three years as required by economic demands from their employment. In California, the enrollment for MEP in the school year of 2024-2025 was 72,983 students across 540 districts. The main goal of MEP is to help students manage academic and social "roadblocks", including possible language barrier considerations.

Participant Overview

The EPIC in summer 2025 served a student population aged 10-18, with 47.9% of participants identifying as female and 52.1% identifying as male. The 715 students included 32.6% students identifying as Hispanic/Latino, 31.9% identifying as White, 23.1% identifying as Asian, 3.3% as Black/African American and 1.4% as Native American and the final 7.8% declining to identify or identifying as other. While all participants' parents were solicited for approval to participate in our IRB approved survey, some opted out and challenges with administering a paper-based survey and matching student names led to only 206 matched pre/post surveys. This smaller sample group was representational of the total population with percentages of gender and race/ethnicity matching the total groups' make-up.

Methods

This study examines changes in student interest in engineering before and after participation in the EPIC. This work uses two complimentary methodologies:

- One focuses on considering changes in participants' survey responses pre and post by aggregating participants into three groups based on socioeconomic differences of their home community, using zip code level household income.
- the second compares student experience based on structural and context-based challenges and their relationship to confidence in engineering.

A total of 206 participants completed both the pre- and post-surveys (with matching identifiers). Surveys were administered during the camp under an IRB approved process. Pre-program and post-program surveys included demographic questions, items related to engineering exposure and encouragement, and Likert-scale measures of interest, belonging, and confidence.

Socio-economic Data Methodology

Individual family income data was not included in the analysis, and instead, family home address zip code was used to examine and consider the local context for a participating student in terms of general neighborhood economic opportunities. Zip code correspondence to educational opportunities is well studied [29] and allowed for a broad view of considering student experience without individualizing socio-economic analysis. Analysis involving socio-economic background is restricted to 193 students from whom valid zip code information was available. The 13 students who did not have usable zip code data were participants in the MEP, and their responses were grouped in the low socio-economic community group based on the nature of the MEP program, not the average income from a specific zip code.

Student zip code data was cleaned and standardized prior to analysis and matched with U.S. Census data to obtain average household income estimates at the zip-code level. These estimates reflect area-level averages and do not represent the actual household income of individual participants. Although most zip codes were primarily within California, a small number of out-of-state zip codes were retained and classified using the same income-based methodology. All data cleaning, processing, and analysis were conducted in RStudio using the dplyr, tidyr, and ggplot2 packages. The primary outcome variable was student response to the survey statement, "I have a high interest in engineering," collected on both pre- and post-program surveys.

Zip codes were then categorized based on California definitions of economic (family) status [30]. The income groups are categorized as follow:

Income Groups	**Income Range**
Lower Income	< $63,674
Middle Income	$63,674 - $190,644
Upper Income	> $190,644

Challenge->Confidence Data Methodology

Additional analysis in this study considered two complementary dimensions of students' experiences with engineering:

(1) structural and contextual challenges related to access and prior exposure, and

(2) confidence in engineering, including interest, belonging, and perceived self-efficacy.

Both dimensions were operationalized using composite scores derived from pre- and post-program survey responses. This approach allowed for examination of relationships between background-related challenges and engineering confidence, as well as changes in confidence following participation in the EPIC program, via the selection of survey data to construct a **challenge score** and a **confidence score** for each participant.

The **challenge score** represents cumulative structural and contextual barriers to engineering access prior to EPIC participation. Higher challenge scores indicate greater barriers, while lower or negative scores indicate fewer barriers or greater prior access. While individual identity is complex and intersectional, for this analysis, we focused on coding any indication of identification with a group that has been historically marginalized in engineering as a challenge while identifying with an over-represented or majority group as a benefit. These scores were aggregated to create a sum to represent total challenges for an individual based on multiple characteristics.

Challenge scores were calculated using demographic, exposure, and contextual indicators summarized in **Table 1**.

Table 1. Components of Challenge Score

Challenge Category	Scoring Criteria
Gender	Male = 0; Female = +1
Race/Ethnicity	White or Asian = 0; All other race/ethnicity = +1
Socioeconomic Context (ZIP Code–Based Income)	High income (≥ $190,644) = –1; Middle income ($63,674 - $190,644) = 0; Low income (< $63,674) = +1
Initial Exposure to Engineering	"As long as I can remember" = –1; All other responses = 0
Encouragement to Study Engineering	–0.5 for each person selected as having encouraged the student to pursue engineering

The **confidence score** captures students' affective and intentional alignment with engineering, including interest, sense of belonging, perceived ability, and intentions to pursue engineering pathways. Higher confidence scores indicate stronger alignment with engineering.

Confidence scores were calculated using survey items summarized in **Table 2**.

Table 2. Components of Confidence score

Confidence Category	**Scoring Criteria**
Intentions to Study Engineering	Don't plan to major in engineering = –1; Not sure = 0; Considering engineering and other majors = 1; Plan to study engineering in college = 2
Interest in Engineering	Highly disagree = –2; Somewhat disagree = –1; Neutral = 0; Somewhat agree = 1; Highly agree = 2
Sense of Belonging	"I fit in well with others that like or do engineering" scored –2 to +2
Engineering Self-Efficacy	"I am confident in my ability to be an engineer" scored –2 to +2

Using pre-program survey data, each participant was assigned both a challenge score and a baseline confidence score. These values were used to explore relationships between cumulative challenge and engineering confidence prior to EPIC participation.

Following program completion, confidence scores were recalculated using post-program survey responses with identical scoring criteria. The difference between post- and pre-program confidence scores was calculated for each participant and used as an indicator of change in engineering confidence associated with EPIC participation.

These combined methodologies allowed us to build a more comprehensive view of student experience in EPIC and in particular the impact of the program.

Results

Our analysis reveals aspects of the students participating in EPIC and the impact of the program based on their community socio-economic grouping and based on considering a somewhat holistic measure of challenge and confidence. In general, we see that students with more challenges enter the program expressing some hesitancy, but for all student groups the program creates positive outcomes in terms of considering a future in engineering.

Socio-economic data results

Figures 1-3 show the range of responses for students grouped by community income level: lower-income community (Figure 1; n = 26, 12.6% of the total group), middle-income community (Figure 2; n = 150, 72.8% of the total group), and upper-income community (Figure 3; n = 30, 14.5% of the total group). For comparison, in 2023, 34.8% of Californians were living in poverty or near poverty (corresponding to the low-income community designation), and 13.3% were in the upper-income bracket (earning ≥ $200K). It is not surprising that EPIC has an overrepresentation of middle- and upper-income community participants compared to state demographics. Despite robust scholarship opportunities, the realities of program costs and the cultural factors that contribute to a youth's participation in a residential summer program likely led to stronger participation from middle and upper-income community members.

In addition, the data show that larger proportions of students from the lower-income community group express more hesitation regarding their "interest in engineering." Within this group, responses ranged from "somewhat disagree" to "somewhat agree" to the statement, "I have a high interest in engineering." Specifically, 42% of the lower-income group fell within this range, compared to 34% of the middle-income group and 33% of the upper-income group. In contrast, none of the thirty participants in the upper-income community group selected a response lower than "somewhat agree" on the pre-program survey, suggesting that this group may be more "primed" for engineering education than students in the other groups.

Regardless of community socioeconomic grouping, the vast majority of participants in all groups shifted from the pre-program survey (red) to more positive post-program responses (blue), with the exception of one student in the lower income group. This overall positive shift is reflected in the combined aggregate data shown in Figure 4. For example, 66% of students reported that they “highly agree” with the statement “I have a high interest in engineering” on the pre-program survey, compared to 73.3% on the post-program survey—an increase of 7.3%.

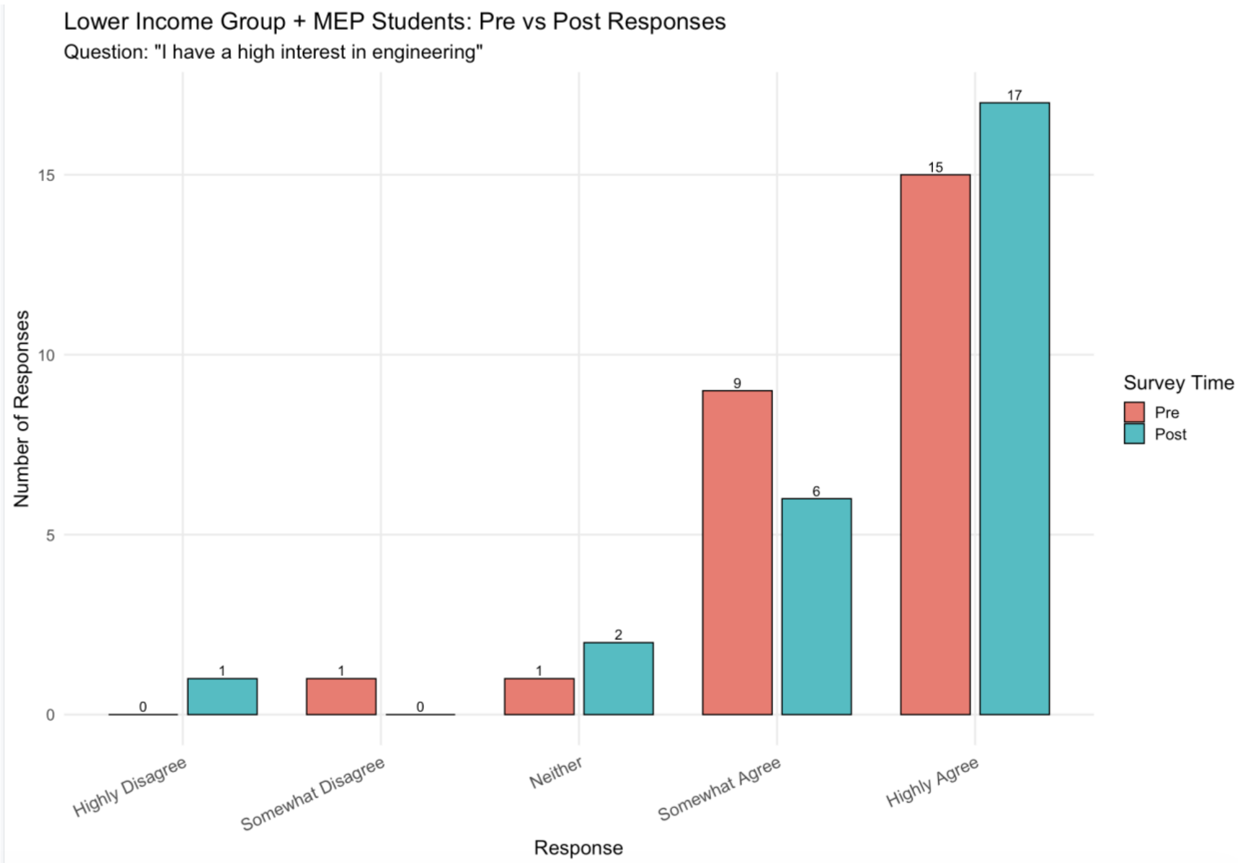

Figure 1 Bar chart comparison of student’s pre-program and post-program survey responses, grouped based on student community socio-economic status. Showing results for lower income community group (including MEP students), (n=26).

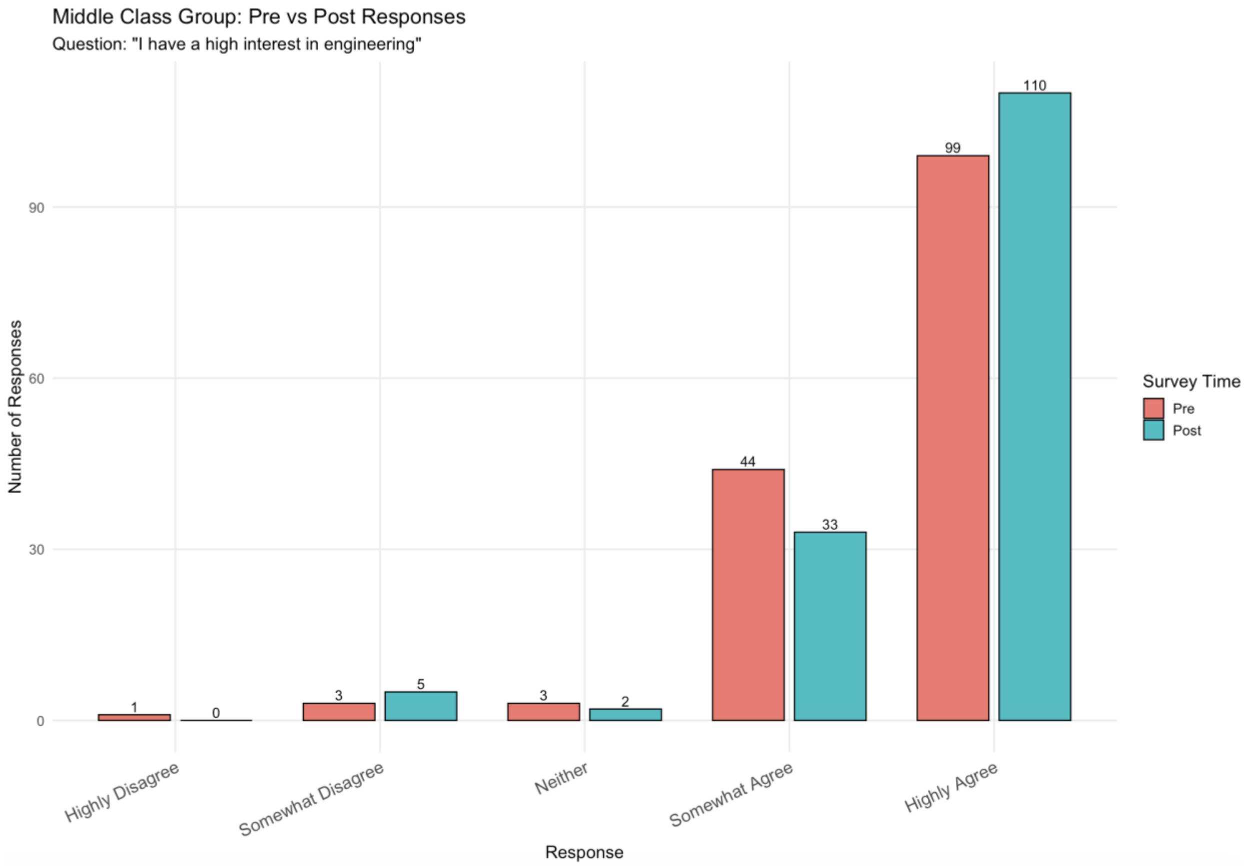

Figure 2 Bar chart comparison of student's pre-program and post-program survey responses, grouped based on student community socio-economic status. Showing responses for middle class community group (n=150), which represents the largest grouping of participants.

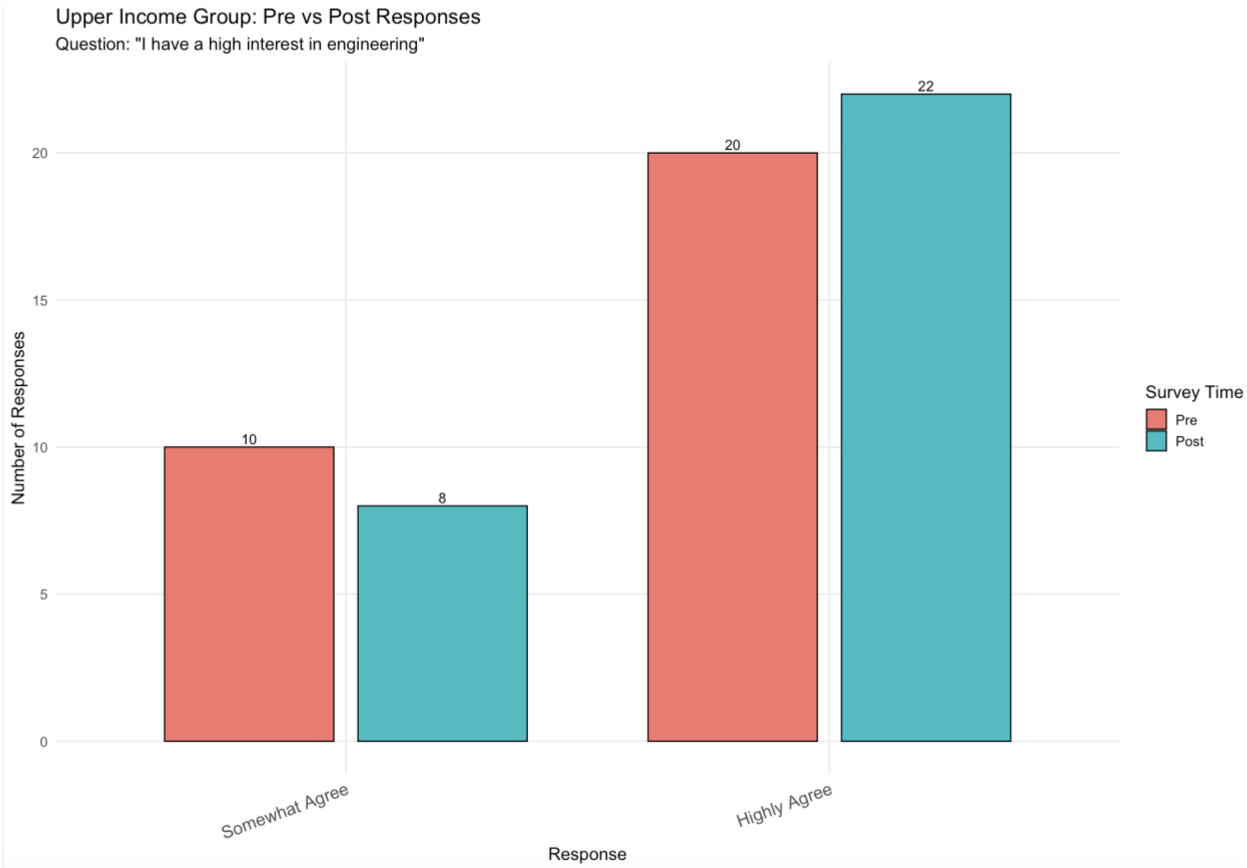

Figure 3 Bar chart comparison of student's pre-program and post-program survey responses, grouped based on student community socio-economic status. Showing responses for upper income community group (n=30). Note responses never below "somewhat agree".

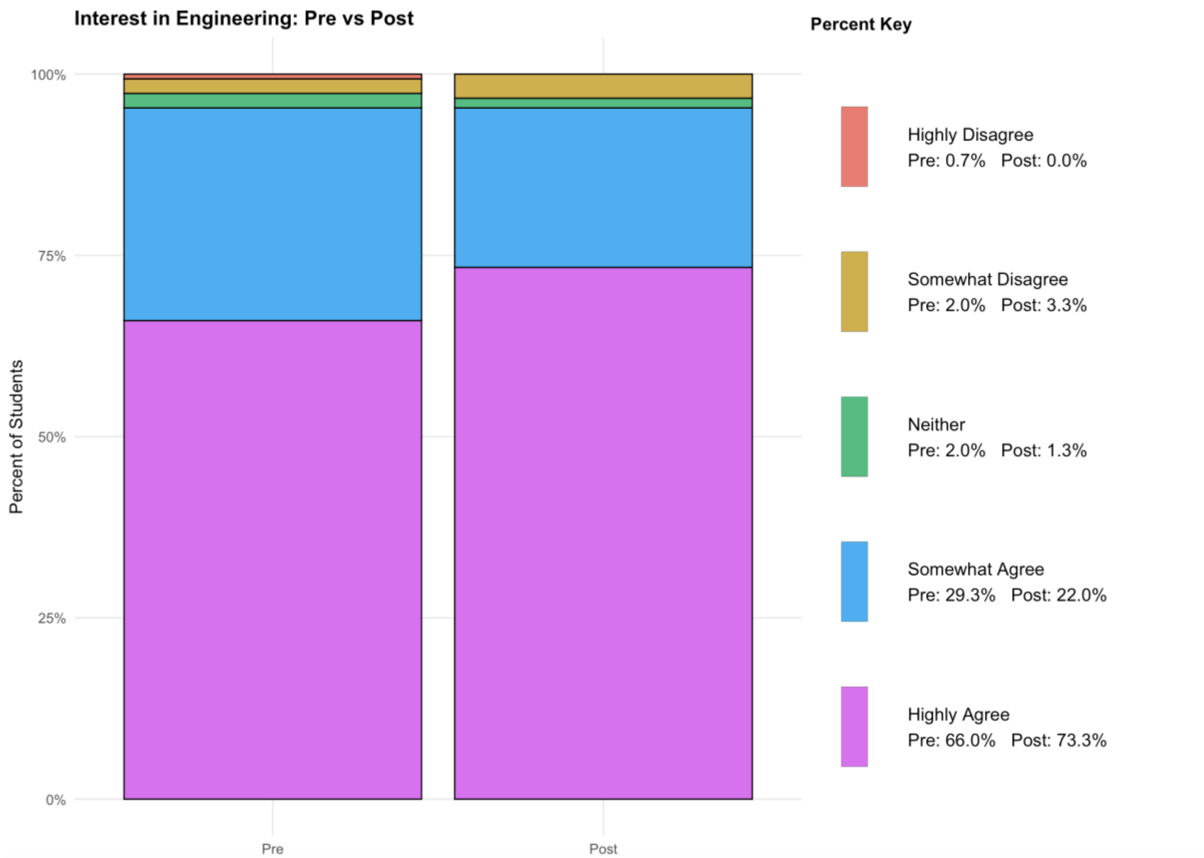

Figure 4 Aggregate stacked bar chart comparison of student's pre-program and post-program survey responses about their agreement with the statement "I have a high interest in engineering" showing the overall positive impact of the program.

Challenge->confidence data results

The relationship between the challenges that a student faces and their confidence in engineering prior to participation in EPIC is shown in Figure 5. While there are some outliers, the trend line in the graph shows that there is a downward slope of –0.6132. This indicates that the general outcome of having more challenges is lower confidence in engineering.

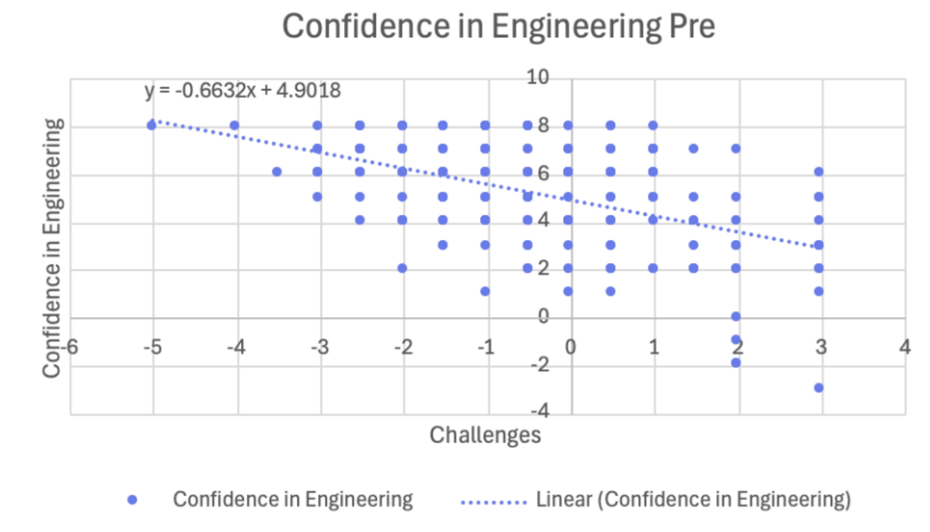

Figure 5 Data plot of student confidence in engineering vs their **structural and contextual challenges** related to access and prior exposure to engineering for the pre-program survey data (slope = -0.6132).

To show how the camper's confidence in engineering changed with the completion of EPIC, we graphed the challenge versus confidence score for the post-program surveys (Figure 6) as well as calculated the difference between pre and post program confidence score for each camper. Figure 6 shows that after the program, students' confidence in engineering has increased as seen with the decreased slope of –0.4584 (an increase of 0.15). In addition, Figure 7 shows a frequency graph of the difference in confidence for individual students, showing overall, the majority of students had increased confidence after attending EPIC as shown by the majority of respondents having a positive shift in confidence (n=109) versus those with a negative shift (n=33).

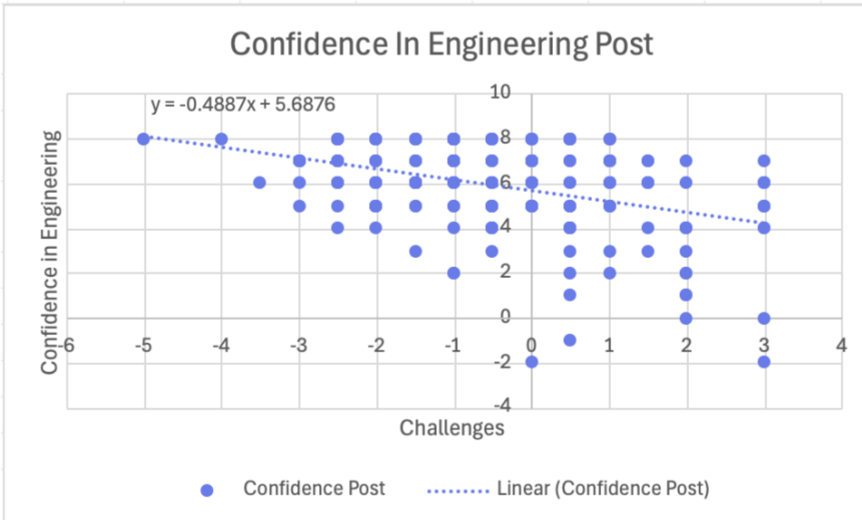

Figure 6 Data plot of student confidence in engineering vs their **structural and contextual challenges** related to access and prior exposure to engineering for the post-program survey data, (slope = -0.4584)

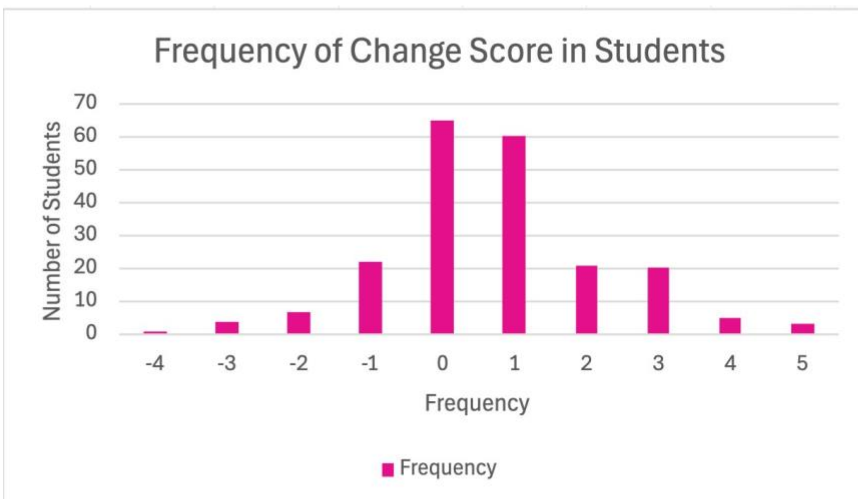

Figure 7 Frequency data for the change in student confidence score from pre to post program, for example showing 60 students confidence increased by one Likert scale, 20 by two Likert scale, etc.

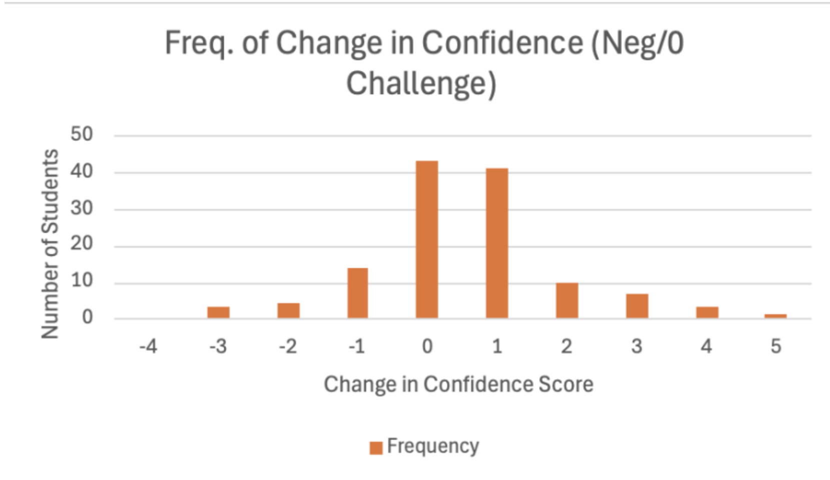

Figure 8 Data plot showing the change in student confidence in engineering for students with fewer challenges, measured by their **structural and contextual challenges** related to access and prior exposure to engineering (n=126), showing that students with fewer challenges tend to have a shift in confidence of 0 to 1.

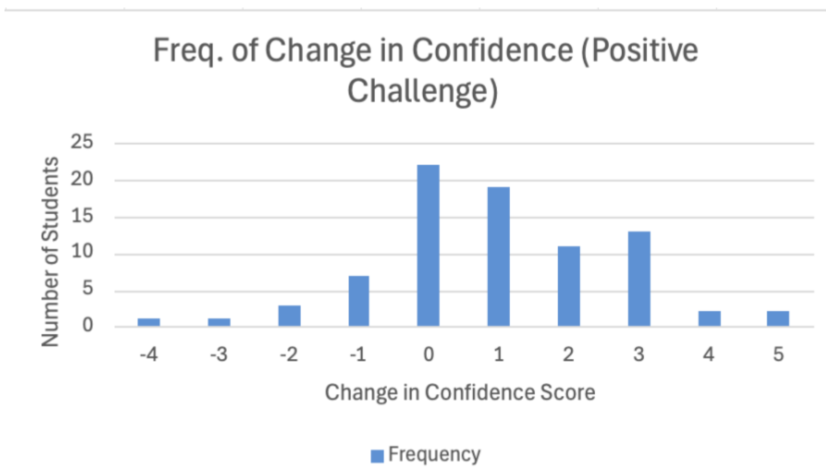

Figure 9 Data plot showing the change in student confidence in engineering for students with challenges, measured by their **structural and contextual challenges** related to access and prior exposure to engineering (n=81), showing that students with more challenges tend to have a larger shift in confidence then those in Figure 8.

While Figure 7 shows the overall positive shift in confidence for the whole student population, Figures 8 and 9 show this shift with respect to two different student groups (those with and without challenges). In Figure 8 (no challenges), almost two thirds had a 0 or negative challenge in confidence score. While in Figure 9 (challenges), we see a significantly larger portion of the population has a positive shift of 1 to 5 points. This shift is consistent with the hypothesis that there is a greater positive effect on students with higher challenge scores than those with lower challenges. Additionally, students with no change in their confidence scores were found to be students that *all* started with *positive* confidence scores. This could indicate that those that did not have a change in confidence were those who already felt confident in their ability to pursue engineering.

Discussion

This work examines the impacts of participation in a summer outreach program designed to increase students' interest in engineering. Using two complementary methodologies, we explored how students from diverse backgrounds experienced the program. Overall, participation was associated with increases in students' confidence and interest in engineering. At the same time, our findings indicate that students enter the program with differing levels of prior exposure, confidence, and perceived barriers, which shape their initial experiences.

These differences in student experience are closely tied to their socio-economic context. Data from the 2025 cohort show that students from lower-income contexts generally reported lower initial confidence and familiarity with engineering, while students from middle- and upper-income contexts more often demonstrated early confidence and enthusiasm. These patterns suggest that early perceptions of engineering are shaped less by inherent ability and more by differences in prior access and exposure. Importantly, post-survey results indicate that these initial disparities diminished over the course of the program, with students across groups demonstrating more comparable levels of confidence and interest by the end.

Two co-authors worked in the EPIC program in roles as the Director Assistant and as Lab Assistant and made personal observations of student engagement throughout the program lab activities. Their autoethnography observations include seeing high levels of interest, participation, and readiness to learn among students across racial, gender, and socioeconomic backgrounds. They also observed variations in the ways that students chose to work together in labs. For example, they shared that in the program sessions that included students from the Migrant Education Program (MEP), students did not always want to work together at the onset of lab activities. However, after one or two days in the program as they became more familiar with one another, their attitude towards collaboration increased significantly. This is in contrast to students in later sessions which did not include MEP students, who were generally more likely to jump into teamwork from the start. This observed behavior of 'warming' to engineering and teamwork is consistent with our data showing positive gains in interest in engineering with participation in the program. These observations further support the interpretation that differences in early confidence reflect unequal access to prior opportunities rather than differences in motivation or ability.

Taken together, these results point to structural differences in access as a key driver of disparities in engineering pathways. Programs such as EPIC can therefore play an important role in promoting equity by providing early, immersive engineering experiences to students who may otherwise lack such exposure. The observed reduction in confidence gaps highlights how structured, supportive environments can help overcome early barriers and foster a sense of belonging in engineering.

Based on these findings, we recommend that similar programs explicitly address differences in students' starting points. This includes targeted recruitment, financial support such as scholarships, and intentional program design that supports confidence-building and inclusion. Such equity-focused efforts can broaden participation and create more accessible pathways into engineering.

We acknowledge that identity, challenges, and confidence are complex and shaped by intersectional and individual factors. This study used community-level socio-economic data as a proxy for individual circumstances and categorized students by broad gender and race/ethnicity groupings based on historical patterns of underrepresentation. These approaches do not capture the full diversity of individual experiences. Future work will explore these complexities in greater depth, including examining how team dynamics and identity-aligned collaboration influence students' confidence and sense of belonging.

References

[1] National Science Foundation, *Women, Minorities, and Persons with Disabilities in Science and Engineering*, NSF 23-315, Alexandria, VA, USA, 2023.

[2] Pew Research Center, "STEM Jobs See Uneven Progress in Increasing Gender, Racial and Ethnic Diversity," Pew Research Center, Washington, DC, USA, 2021. [Online]. Available: https://www.pewresearch.org

[3] C. Hill, C. Corbett, and A. St. Rose, *Why So Few? Women in Science, Technology, Engineering, and Mathematics*, Washington, DC, USA: American Association of University Women, 2010.

[4] A. Godwin and G. Potvin, "Pushing and pulling Sara: A case study of the contrasting influences of high school factors on engineering identity," *Journal of Engineering Education*, vol. 106, no. 4, pp. 1–32, 2017.

[5] J. M. Smith and J. Lucena, "Invisible innovators: How low-income, first-generation students use their funds of knowledge to belong in engineering," *Engineering Studies*, vol. 8, no. 3, pp. 1–26, 2016.

[6] J. C. Major, *More Than Income: Socioeconomic Inequality, Trauma, and the Pathways of Low-Income Undergraduate Engineering Students*, Ph.D. dissertation, School of Engineering Education, Purdue University, West Lafayette, IN, USA, 2022.

[7] T. J. G. Tracey and S. B. Robbins, “Stability of interests across time: Evidence from longitudinal studies,” *Journal of Vocational Behavior*, vol. 67, no. 1, pp. 89–106, 2005.

[8] P. M. Sadler, G. Sonnert, Z. Hazari, and R. Tai, “Stability and volatility of STEM career interest in high school,” *Science Education*, vol. 96, no. 3, pp. 411–427, 2012.

[9] K. A. Miller, G. Sonnert, and P. M. Sadler, “The influence of student enrollment in pre-college engineering courses on their interest in engineering careers,” *Journal of Pre-College Engineering Education Research*, vol. 10, no. 1, Article 7, 2020. https://doi.org/10.7771/2157-9288.1235

[10] National Academy of Engineering and National Research Council, *Engineering in K–12 Education: Understanding the Status and Improving the Prospects*, Washington, DC, USA: National Academies Press, 2009.

[11] J. Moore, J. Tank, and K. Kersten, “The need for a systems approach to K–12 engineering education,” *Science Education*, vol. 99, no. 2, pp. 1–28, 2015.

[12] A. Kirn and A. Godwin, “The role of recognition in engineering identity development,” *Journal of Engineering Education*, vol. 108, no. 3, pp. 1–26, 2019.

[13] F. A. Fouad and P. L. Smith, “A test of a social cognitive model for middle school students: Math and science,” *Journal of Vocational Behavior*, vol. 48, no. 3, pp. 1–19, 1996.

[14] D. Dabney, R. H. Tai, A. Almarode, J. L. Miller-Friedmann, and A. Sonnert, “Out-of-school time science activities and their association with career interest in STEM,” *Science Education*, vol. 96, no. 4, pp. 1–23, 2012.

[15] R. Dou, J. Hazari, G. Sonnert, and P. M. Sadler, “Early informal STEM experiences and STEM identity: The importance of curiosity and relevance,” *Research in Science Education*, vol. 49, no. 2, pp. 1–24, 2019.

[16] T. Robinson, A. Kirn, J. Amos, and I. Chatterjee, “The effects of engineering summer camps on middle and high school students’ engineering interest and identity formation: A multi-methods study,” *Journal of Pre-College Engineering Education Research*, vol. 13, no. 2, Article 6, 2023.

[17] C. Amanova, P. M. Wright, and K. Brynteson, “From camps to careers: Analyzing the impact of summer STEM camps on students’ career choices,” *Journal of Pedagogical Research*, vol. 9, no. 5, pp. 159–179, 2025.

[18] K. Mohr-Schroeder, C. Jackson, and C. Cavalcanti, "Examining the impact of an engineering camp on students' interest and confidence," *Journal of Research in Science Teaching*, vol. 51, no. 2, pp. 1–27, 2014.

[19] T. Maltese and R. H. Tai, "Eyeballs in the fridge: Sources of early interest in science," *International Journal of Science Education*, vol. 31, no. 5, pp. 1–23, 2009.

[20] A. Kirn, A. Godwin, and D. Benson, "Engineering identity development in informal learning environments," in *Proc. ASEE Annual Conf.*, Salt Lake City, UT, USA, 2018.

[21] A. Godwin, "The development of a measure of engineering identity," *Journal of Engineering Education*, vol. 105, no. 2, pp. 1–27, 2016.

[22] A. Godwin and A. Kirn, "Understanding engineering student identity through the lens of recognition," *Frontiers in Education Conference Proceedings*, IEEE, 2020.

[23] J. C. Major and A. Godwin, "Socioeconomic inequality and the invisible students of engineering education," *Journal of Engineering Education*, vol. 108, no. 3, pp. 1–30, 2019.

[24] J. C. Major, A. Godwin, and A. Kirn, "Intersectionality and socioeconomic pathways in engineering," *Engineering Studies*, vol. 10, no. 2, pp. 1–28, 2018.

[25] K. Quadlin, "Funding college and the risks of engineering," *Social Forces*, vol. 96, no. 2, pp. 1–30, 2017.

[26] Chen, K. C., & Schlemer, L. T., & Smith, H. S., & Fredeen, T. (2011, June), *Evolving a Summer Engineering Camp through Assessment* Paper presented at 2011 ASEE Annual Conference & Exposition, Vancouver, BC. 10.18260/1-2—17939

[27] Chen, K.C., & Belter, D., & Fredeen, T., & Smith, H., & Magnusson, S. (2009), Inspiring A Diverse Population Of High School Students To Choose Engineering As A Career Path. ASEE Annual Conference Proceedings 2009

[28] Manzano, M., & Della, E., & Cacho, G., & Miller, D., & Derickson, D. (2021, July), *Evaluation on a New Virtual Program Format: How Does an Engineering Summer Program Evolve and Adapt to Meet the Needs of an Increasingly Diverse Student Population During a Pandemic? (Evaluation, Diversity)* Paper presented at 2021 ASEE Virtual Annual Conference Content Access, Virtual Conference. 10.18260/1-2—37113

[29] Opportunity Atlas. *Opportunity Atlas: Mapping the Childhood Roots of Social Mobility*. Opportunity Insights & U.S. Census Bureau, www.opportunityatlas.org

[30] Marshall, Kendrick. "Who qualifies as middle class in California? Here's how much

income you need in 2025.” Sacramento Bee. Updated March 3, 2025. https://www.sacbee.com/news/california/article301133279.html