

Enhancing Adolescents’ Human and Social Capital in STEM: Evidence from the Prefreshman Engineering Program (PREP)

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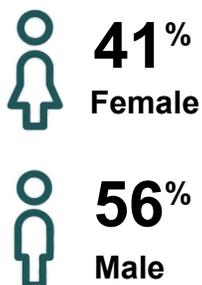
STEM jobs in the U.S. are projected to grow at a rate near double (8.0%) than any other (3.4%; U.S. Bureau of Labor Statistics, 2020), yet STEM career interest among the nation’s youth, especially for females and underrepresented racial/ethnic minorities (URMs; Blacks/Latinx/Native Americans), is declining as they progress through their education (Sadler et al., 2012; Saw, 2018). Prefreshman Engineering Program (PREP) and many out-of-school time (OST) STEM programs across the country show promise in promoting STEM learning and motivation among adolescents (Kitchen et al., 2018; Saw et al., 2019). However, little is known about the *mechanisms by which OST STEM programs have a positive impact* (Young et al., 2017). In this study, we interviewed 32 middle/high school students from five PREP sites who described, in their own words, how PREP supports their learning and motivation in STEM.

Key Findings

1. Students reported gaining advanced STEM knowledge and skills at PREP that prepare them for, and provide a boost in confidence in, the regular school year.
2. Students reported learning real-world STEM knowledge and applying it to hands-on projects and activities at PREP.
3. Students reported expanding their STEM-oriented social network by forming close bonds with peers and mentors met at PREP who help foster positive STEM values and beliefs.
4. Overall, PREP appears to support STEM pathways among adolescents by enhancing their STEM-focused human and social capital through offering rigorous coursework, real-world connections, and a community of shared interest in STEM.

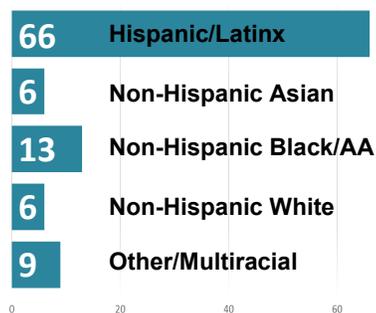
Participant Demographics

Gender

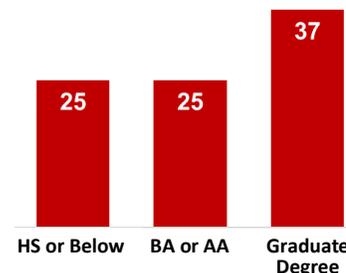


*3% other gender or not reported

Race/Ethnicity %



Parent Highest Degree %



*13% not reported

1 Advanced STEM Preparation - Students reported rigorous academic training at PREP that prepares them for school coursework, increases ability, and boosts confidence in STEM.



Maria
8th Grade Latina

I think PREP prepares us not only for our future but also just in school, because I'm learning things now in my eighth-grade year that I already learned it in PREP in my 6th grade summer. It's helping me be ahead of my class and it's helping me be better prepared for my future.

PREP has helped me a lot to improve in science and math, extremely!



Sandra
8th Grade Latina



Rachel
8th Grade Black Girl

In year two, the math that we did helped me. What we would do in PREP prepared me for the next year. I would be like, "Oh, I did that." I remember doing proofs this year, but we did proofs in PREP and I was like, "Oh, I have this. I'm set. I'm good."

PREP Staff in Action



Edgar Diaz, University of Houston—Downtown (UHD). Edgar has been with UHD PREP since 2013, starting as a Program Assistant Mentor (PA) for Year 1 students. As a PA, Edgar gained a passion for PREP from students' motivation and eagerness to learn and overall enjoyment of the program. While an undergraduate at UHD Edgar continued to work at PREP part time until he graduated with a degree in mathematics. After graduating, Edgar began working for UHD PREP full-time and is now helping lead the program and insure students continue to receive valuable STEM enrichment and an enjoyable program experience.

2 Real-World STEM Knowledge Building and Application - Students reported the opportunity to learn directly at PREP from professionals and apply learned knowledge in real-world STEM settings.

PREP brings in different people. They can be parents of students at PREP or someone in a STEM profession, and they spend time just talking about what they do and how they got there. And some of them even went to PREP. So it was really cool to think, oh, that could be me in 10 years.



Lucia
10th Grade Latina



Arthur
9th Grade Black Boy

In year one, we built a roller coaster. And we got to learn about the positive and negative G's, and all that went into building a roller coaster.

The hands-on things are cool. This summer, we were building boats and I learned a lot about buoyancy.



Russel
10th Grade Black Boy

3 Community of Shared Interest in STEM - Students reported expanding networks and forming close bonds with STEM-oriented peers and mentors at PREP, supporting knowledge building while enhancing positive beliefs in STEM.



Olivia
9th Grade Latina

In PREP I've met some of my best friends. I used to not talk that much, I used to be shy but in PREP it's completely different than school. I got closer with some of my school friends and I made new friends from other districts. The mentors they're really great to talk to, they are like our role models in science.

I realized that more minds are better than one. My project partners came up with ideas I didn't think of that really helped, and helped me understand that you have to listen to people and work together to get a better outcome.



Eric
8th Grade White Boy

Summary

Three major mechanisms of OST programs were reported by PREP participants as enhancing their STEM learning and motivation. By providing students with the opportunity to learn advanced STEM curriculum, apply what they learn to hands-on and real-world projects, and expand their social networks with STEM-oriented peers and mentors, PREP represents a promising model of OST STEM programs for supporting STEM pathways, particularly among underrepresented and underserved students. This study supports the recommendations of the National Research Council (NRC, 2015) for OST programs to provide participants opportunities to collaborate and explore STEM in ways that are relevant to them and to connect STEM learning to real-world experiences.

PREP Year 3 students study remotely operated vehicles in the Manufacturing Lab at **St. Mary's University**.



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- **Findings of this study have been presented at the 2021 American Educational Research Association (AERA) annual conference, April 8, 2021.**
- All names mentioned in this report are pseudo names and not actual names of PREP participants.



References

- Kitchen, J. A., Sonnert, G., & Sadler, P. M. (2018). The impact of college and university-run high school summer programs on students' end of high school STEM career aspirations. *Science Education*, 102(3), 529-547.
- National Research Council. (2015). *Identifying and supporting productive STEM programs in out-of-school settings*. Washington, DC: National Academies Press.
- Sadler, P. M., Sonnert, G., Hazari, Z., & Tai, R. (2012). Stability and volatility of STEM career interest in high school: A gender study. *Science Education*, 96(3), 411-427.
- Saw, G., Chang, C.-N., & Chan, H.-Y. (2018). Cross-sectional and longitudinal disparities in STEM career aspirations at the intersection of gender, race/ethnicity, and socioeconomic status. *Educational Researcher*, 47(8), 525-531.
- Saw, G. K., Swagerty, B., Brewington, S., Chang, C. N., & Culbertson, R. (2019). Out-of-school time STEM program: Students' attitudes toward and career interests in mathematics and science. *International Journal of Evaluation and Research in Education*, 8(2), 356-362.
- U.S. Bureau of Labor Statistics. (2020). *Employment in STEM occupations*. <https://www.bls.gov/emp/tables/stem-employment.htm>
- Young, J., Ortiz, N., & Young, J. (2017). STEMulating Interest: A meta-analysis of the effects of out-of-school time on student STEM interest. *International Journal of Education in Mathematics, Science and Technology*, 5(1), 62-74.