

STEM Curriculum as a Catalyst: Analyzing Parental Education, STEM Involvement in High school Students' Academic Success

Shuhan Ai

InterActions Journal Editor
PhD student at School of Education & Information Studies,
University of California, Los Angeles

April 2024 | AERA Conference | Philadelphia, PA



Research Background

- **Motivation :**
 - Education **fairness** and **social justice** ~ policymaker, educator
 - 1966 Coleman Report: disparities in educational opportunities and outcomes ~ **race**, **socioeconomic status**
 - **High school students' academic achievement** ~ race, parental education level, enrollment in STEM courses (e.g., Davis-Kean, 2005; Harding et al., 2017)
- Leveraging the High School Longitudinal Study of 2009 (HSLs:09), this study investigates the relationship between **race**, **parental education**, and **enrollment in STEM courses** on **high school students' academic achievement**.



Research Questions

2



How does the **GPA of high school students** vary across different **racial groups** and **various levels of parental education**?

To what extent do **STEM credits** improve the prediction of students' high school GPA above and **beyond race and parental educational level**?

Is the relationship between STEM credits and high school GPA **moderated by race**, after controlling for parental educational level?

Literature Review

3

- **Parental Education:**
 - Indicator of **SES** and **access to resources** ~ opportunities and outcomes (Sirin, 2005).
 - Higher Academic achievement ~ Higher levels of parental education (Harding et al., 2017; Davis-Kean, 2005; Cimpian et al., 2016)
 - early college predisposition; higher aspirations
 - increased likelihood of students taking advanced courses
- **Race on K-12 students' academic achievement**
 - School **racial isolation** have negative effect on K-12 math achievement (Mickelson et al., 2013)
 - widen as student move through grades
 - Disparities in **STEM education** faced by students of color (Harper, 2010)
 - degree aspirations and career aspirations
- **Other Factors**
 - **Social-contextual** factors - e.g., family, school environment, peer relationships;
 - **personal factors** - e.g., cognitive abilities, motivation, self-regulation (Lee & Shute, 2010).





- **Cultural Capital:**

- Cultural capital, as described by Bourdieu (Bourdieu, 1990; Bourdieu & Passeron, 1977), represents investments on the part of the dominant class in reproducing a set of symbols and meanings, which are misrecognized and internalized by the dominated class as their own.
 - **Cultural capital** is like a toolkit of social skills, knowledge, and behaviors that can reproduce social inequalities (Bourdieu, 1985).
 - **Embodied Cultural Capital** (What You Carry Inside, personality)
 - **Objectified Cultural Capital** (What you own, book)
 - **Institutionalized Cultural Capital** (Your Diplomas and Titles)
- Bourdieu's theory allows for a deeper understanding of **how various forms of capital interact to influence educational outcomes**. This is particularly relevant to this study as it investigates the impact of **parental education** on students' academic success.

Data and Sample

5

- **HSLs:09 (NCES):**
 - High School students' school experiences, parental involvement, STEM self-efficacy, college majors, and career aspirations.
 - Base Year in 2009 (HS freshman year)
 - First follow-up in 2012 (HS senior year)
 - Second follow-up in 2016 (3 years after high school).
 - Final sample of 14,260 observations.
- **Four Key Variables of Interest:**
 - Overall **GPA** in students' **senior year** (outcome)
 - Students' **racial identity** (6 - White, Asian, Black, Hispanic/Latino, Native American, and Pacific Islander)
 - **Highest educational level** reached by a **student's parent** (6 - less than high school, high school, Associate, Bachelor, Master, Ph.D./M.D./Law/Other)
 - The **number of credits students earned in STEM** courses



Findings

Table 1. High School Students' GPA and STEM Credits Across Racial Groups

Race/Ethnicity	Mean GPA	SD GPA	Mean STEM Credits	SD STEM Credits	Percentage
White	2.926	0.753	7.877	2.353	62.69
Asian	3.248	0.620	9.012	2.532	8.40
Black	2.418	0.771	7.371	2.458	10.33
Hispanic/Latino	2.507	0.801	7.095	2.553	17.32
Native American	2.430	0.810	6.746	2.772	0.73
Pacific Islander	2.633	0.744	7.260	2.257	0.53

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study (HSLs) 2009, 2012, 2016, 2017.

Table 2. High School Students' GPA and STEM Credits Across Parental Educational Level

Parental Education	Mean GPA	SD GPA	Mean STEM Credits	SD STEM Credits	Percentage
Less than High School	2.289	0.832	6.634	2.793	8.22
High School	2.633	0.800	7.409	2.515	39.82
Associate	2.783	0.743	7.775	2.382	15.21
Bachelor	3.123	0.646	8.374	2.190	23.36
Master	3.230	0.611	8.435	2.128	9.56
Ph.D./M.D./Law/Other	3.310	0.585	8.780	2.205	3.47

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study (HSLs) 2009, 2012, 2016, 2017.



Findings

Table 3. Race, Parental Education, STEM Credits, and Interaction Terms as Predictors of High School Students' GPA

Variable	B	SE	t	ΔR^2	Total R^2	F for Δ
<i>Model 1 (race as the only predictor, White the is reference group)</i>						
Asian	0.322	0.023	13.88 ***			
Black	-0.509	0.021	-23.99 ***			
Hispanic/Latino	-0.419	0.017	-24.48 ***	0.092	0.092	
Native American	-0.497	0.074	-6.68 ***			
Pacific Islander	-0.294	0.087	-3.38 ***			
<i>Model 2 (race and parental education level as predictors, less than high school is reference group)</i>						
Asian	0.238	0.022	10.699***			
Black	-0.459	0.020	-22.800***			
Hispanic/Latino	-0.261	0.017	-15.208***			
Native American	-0.428	0.070	-6.078***			
Pacific Islander	-0.248	0.082	-3.016**			
High School	0.270	0.024	11.312***	0.094	0.185	405.002 ***
Associate	0.412	0.027	15.378***			
Bachelor	0.706	0.025	27.740***			
Master	0.805	0.030	27.246***			
Ph.D./M.D./Law/Other	0.857	0.039	21.914***			



Findings

Model 3 (race, parental education level, STEM credits as predictors)

Asian	0.108	0.020	5.346***			
Black	-0.405	0.018	-22.329***			
Hispanic/Latino	-0.202	0.016	-13.039***			
Native American	-0.298	0.064	-4.697***			
Pacific Islander	-0.178	0.074	-2.398*			
High School	0.184	0.022	8.540***	0.153	0.339	3313.467***
Associate	0.281	0.024	11.586***			
Bachelor	0.510	0.023	21.998***			
Master	0.606	0.027	22.591***			
Ph.D./M.D./Law/Other	0.626	0.035	17.629***			
STEM Credits	0.130	0.002	57.436***			

Model 4 (including interaction terms)

Asian	0.510	0.073	7.017***			
Black	-0.463	0.058	-7.989***			
Hispanic/Latino	-0.398	0.045	-8.772***			
Native American	-0.517	0.168	-3.078**			
Pacific Islander	-0.155	0.251	-0.617			
High School	0.178	0.022	8.263***			
Associate	0.274	0.024	11.299***	0.003	0.342	13.542***
Bachelor	0.504	0.023	21.763***			
Master	0.601	0.027	22.437***			
Ph.D./M.D./Law/Other	0.628	0.035	17.718***			
STEM Credits	0.128	0.003	43.857***			
Asian× STEM Credits	-0.044	0.008	-5.636***			
Hispanic/Latino × STEM Credits	0.027	0.006	4.666***			

Note: B=unstandardized regression coefficients; SE = standard error; ΔR^2 = change in percent of variance accounted for by additions to the model; total R^2 = cumulative coefficient of multiple determination or total amount of variance accounted for by model; F = Statistical test value for the regression model. Model 4 only include statistically significant interaction variables. * $p < .05$. ** $p < .01$. *** $p < .001$.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study (HSLs) 2009, 2012, 2016, 2017.



Limitations



Insufficient Variables: The study's limited range of variables may restrict the ability to fully understand the complex dynamics affecting STEM education outcomes. Science self-efficacy, science identity, science-related skills.



Theoretical Misalignment: The theoretical framework may not adequately capture for the contextual or cultural factors influencing educational outcomes, the finding might oversimplify the complexities of educational disparities.



Limited Generalizability: Given the focus on specific demographic groups and educational settings, the results of the study may not be generalizable to other populations or educational contexts.

Conclusion and Discussion

While race and parental education levels were significant predictors of high school GPA, the inclusion of **STEM credits** markedly improved the model's predictive power.

Students who earned more STEM credits are expected to have higher GPA. However, the impact of STEM credits on GPA is moderated by race, with **Hispanic/Latino students** benefiting more substantially compared to White students, and **Asian students** showing lesser increments in GPA per STEM credit.

Educators can design inclusive STEM programs and provide support to students from underrepresented racial backgrounds. Researchers could further explore additional relevant covariates in the model, such as types of course offerings in high schools, students' extracurricular involvement, and racial composition of high schools, contributing to the knowledge base on effective interventions.



Reference

- Cimpian, J. R., Lubinski, S. T., Timmer, J. D., Makowski, M. B., & Miller, E. K. (2016). Have Gender Gaps in Math Closed? Achievement, Teacher Perceptions, and Learning Behaviors Across Two ECLS-K Cohorts. *AERA Open*, 2(4), 2332858416673617. <https://doi.org/10.1177/2332858416673617>
- Crenshaw, K. (1989). Demarginalizing the Intersection of Race and Sex: A Black Feminist Critique of Antidiscrimination Doctrine, Feminist Theory and Antiracist Politics. In *Feminist Legal Theories*. Routledge.
- Crenshaw, K., Gotanda, N., & Peller, G. (1995). *Critical Race Theory: The Key Writings that Formed the Movement*. The New Press.
- Davis-Kean, P. E. (2005). The Influence of Parent Education and Family Income on Child Achievement: The Indirect Role of Parental Expectations and the Home Environment. *Journal of Family Psychology*, 19(2), 294–304. <https://doi.org/10.1037/0893-3200.19.2.294>
- Delgado, R., & Stefancic, J. (2017). Chapter II. Hallmark critical race theory themes. In *Chapter II. Hallmark critical race theory themes* (pp. 19–43). New York University Press. <https://doi.org/10.18574/nyu/9781479851393.003.0007>
- Harding, J. L., Parker, M. C., & Toutkoushian, R. K. (2017). Deciding about College: How Soon is Soon Enough? *Teachers College Record*, 119(4), 1–40. <https://doi.org/10.1177/016146811711900404>
- Harper, S. R. (2010). An anti-deficit achievement framework for research on students of color in STEM. *New Directions for Institutional Research*, 2010(148), 63–74. <https://doi.org/10.1002/ir.362>
- Harris, J. C., & Patton, L. D. (2019). Un/Doing Intersectionality through Higher Education Research. *The Journal of Higher Education*, 90(3), 347–372. <https://doi.org/10.1080/00221546.2018.1536936>
- Hill, N. E., & Tyson, D. F. (2009). Parental involvement in middle school: A meta-analytic assessment of the strategies that promote achievement. *Developmental Psychology*, 45(3), 740–763. <https://doi.org/10.1037/a0015362>
- Jang, S. T. (2018). The Implications of Intersectionality on Southeast Asian Female Students' Educational Outcomes in the United States: A Critical Quantitative Intersectionality Analysis. *American Educational Research Journal*, 55(6), 1268–1306. <https://doi.org/10.3102/0002831218777225>

Reference

- Ladson-Billings, G. (1998). Just what is critical race theory and what's it doing in a nice field like education? *International Journal of Qualitative Studies in Education*, 11(1), 7–24. <https://doi.org/10.1080/095183998236863>
- Lee, J., & Shute, V. J. (2010). Personal and Social-Contextual Factors in K–12 Academic Performance: An Integrative Perspective on Student Learning. *Educational Psychologist*, 45(3), 185–202. <https://doi.org/10.1080/00461520.2010.493471>
- Matsuda, M., Lawrence, C., Delgado, R., & Crenshaw, K. (1993). *Words That Wound: Critical Race Theory, Assaultive Speech, and The First Amendment*. Faculty Books. <https://scholarship.law.columbia.edu/books/287>
- Mickelson, R. A., Bottia, M. C., & Lambert, R. (2013). Effects of School Racial Composition on K–12 Mathematics Outcomes: A Metaregression Analysis. *Review of Educational Research*, 83(1), 121–158. <https://doi.org/10.3102/0034654312475322>
- Price, M., Polk, W., Hill, N. E., Liang, B., & Perella, J. (2019). The intersectionality of identity-based victimization in Adolescence: A person-centered examination of mental health and academic achievement in a U.S. high school. *Journal of Adolescence*, 76, 185–196.
- Sirin, S. R. (2005). Socioeconomic Status and Academic Achievement: A Meta-Analytic Review of Research. *Review of Educational Research*, 75(3), 417–453. <https://doi.org/10.3102/00346543075003417>
- Solorzano, D. G. (1997). Images and Words that Wound: Critical Race Theory, Racial Stereotyping, and Teacher Education. *Teacher Education Quarterly*, 24(3), 5–19.
- Solorzano, D. G. (1998). Critical race theory, race and gender microaggressions, and the experience of Chicana and Chicano scholars. *International Journal of Qualitative Studies in Education*, 11(1), 121–136. <https://doi.org/10.1080/095183998236926>
- Solorzano, D. G., & Bernal, D. D. (2001). Examining Transformational Resistance Through a Critical Race and Latcrit Theory Framework: Chicana and Chicano Students in an Urban Context. *Urban Education*, 36(3), 308–342.
- Toutkoushian, R. K., Stollberg, R. A., & Slaton, K. A. (2018). Talking ‘Bout My Generation: Defining “First-Generation College Students” in Higher Education Research. *Teachers College Record*, 120(4), 1–38. <https://doi.org/10.1177/016146811812000407>
- Yosso, T. J. (2005). Whose culture has capital? A critical race theory discussion of community cultural wealth. *Race Ethnicity and Education*, 8(1), 69–91. <https://doi.org/10.1080/1361332052000341006>

Thank you!

Contact Information:

ShuhanAi: aishuhan@ucla.edu

InterActions Journal: interactions@gseis.ucla.edu

InterActions Website:

