# CASE STUDY OF PHYSICS COURSETAKING, CONTEXTUAL CHARACTERISTICS, AND PHYSICS ACHIEVEMENT IN URBAN SCHOOLS

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# Subject

- Research has shown that high school physics coursetaking has been a strong predictor of post-secondary science, technology, engineering and mathematics (STEM) study as it is regarded a foundational science.
- Students who take one or two years of physics in high school have shown significantly higher STEM career interest and attainment, as opposed to those who only took a second course in a science other than chemistry.

Tyson, W., Lee, R., Borman, K. M., & Hanson, M. A. (2007). Science, technology, engineering, and mathematics (STEM) pathways: High school science and math coursework and postsecondary degree attainment. J. Education for Students Placed at Risk, 12(3), 243-270.
Sadler, P. M., Sonnert, G., Hazari, Z., & Tai, R. (2014). The Role of Advanced High School Coursework in Increasing STEM Career Interest. Science Educator, 23(1), 1-13.

# Problem

- These research studies are not generalizable at the local level due to differences in physics education and educational policies across states, regions and counties.
- Several studies have indicated that access to physics courses is inequitable
- Students in the lowest socioeconomic status quintile are less likely to take a physics course than students in the highest quintile (32% vs. 56%).

Authors, 2019; White & Tyler, 2015
National Science Board. (2018). *Science and engineering indicators.* Arlington, VA: NCES

# Problem

- This study analyzed the relationship among student physics achievement, school-level socioeconomic status, and school-level physics coursetaking ratio, a proxy for a physics access.
- Additionally, school-level test-taking ratio was examined as a potential mediator of socioeconomic status in a multivariable model with student physics achievement as the dependent variable.

# Research Questions

1. Are there significant differences among contextual characteristics for New York State schools that offer physics?
2. What is the predictive value of socioeconomic status, test-taking ratio, and school size with regard to student physics performance?
3. To what extent does a school's socioeconomic status, mediated by test-taking ratio, predict student physics performance in terms of passing and mastery rates on state standardized exams?

# Research Design

- This is an observational study of New York State public schools (n=721) achievement on a high-stakes physics examination. The quantitative research methods employed in the study are part of a larger non-experimental correlational design.
- The purpose of this study was to identify the extent to which urban schools differed from suburban and rural schools in terms of their socioeconomic status, percentage of total students tested in physics, student achievement, school size and ethnic makeup.

Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). Experimental and quasi-experimental designs for generalized causal inference.

# Research Design

- Multiple linear regression models were generated to determine whether schools' size, socioeconomic status and the percentage of students tested could predict the mean passing and mastery rates of urban schools.

# Data Collection

- Several New York State Education Department (NYSED) data sources were utilized to identify high schools that offered physics, school characteristics, and student achievement during the 2017-18 academic year.
- Sources included the Basic Education Data System; New York State Report Cards, where data were reported for the state as a whole, and for each county, district, and school; and the New York teacher certification database (NYSED, 2013b). All data were publicly available and cross verified among the schools and the state.

NYSED. (2016). Information and reporting services: Public school enrollment. Retrieved from http://www.p12.nysed.gov/irs/statistics/enroll-n-staff/home.html.
NYSED. (2013a). Annual school report cards. Retrieved from https://data.nysed.gov/reportcard.php?year=2013&instid=800000081568.
NYSED. (2013b). New York State Education Department teacher certification lookup. Retrieved from http://eservices.nysed.gov/teach/certhelp/CpPersonSearchExternal.jsp.

# Results/Analysis

- Of the 721 schools included in this study, 24.5% were located in an urban setting.
- A one-way ANOVA with Scheffe post-hoc test showed that urban schools had significantly lower student passing percentages ($M=55.83$, $SD=28.65$) than both suburban ($M=82.09$, $SD=15.86$, $p<.001$) and rural schools ($M=86.24$, $SD=13.9$, $p<.001$).
- Urban schools also had significantly lower student mastery percentages ($M=17.05$, $SD=18.63$) than both suburban schools ($M=39.67$, $SD=18.6$, $p<.001$) and rural schools ($M=38.39$, $SD=20.57$, $p<.001$

# Table 1: Schools Offering Physics in NY State by Locale

| *Locale* | *# Schools* | *% of Schools* | *Tested Students* | *Test-Taking Ratio* | *Passing %* | *Mastery %* |
|---|---|---|---|---|---|---|
| **Urban** | 177 | 24.5 | 14,953 | 6.66 | 55.8 | 17.1 |
| **Suburban** | 320 | 44.4 | 25,610 | 7.75 | 82.1 | 39.7 |
| **Rural** | 224 | 31.1 | 5,641 | 6.90 | 86.2 | 38.4 |
| **Total** | **721** | **100.0** | **46,204** | | | |

# School-Level Predictors of Physics Performance

- Test-Taking Ratio - the amount of students tested per total population 9-12
- Socioeconomic Status  - percentage of free and reduced lunch

# Table 2: Analysis of School Test-Taking Ratio as a Mediator of Physics Passing Rate

| Testing Path | $\beta$ | *B* | *SE (B)* | 95% CI |
|---|---|---|---|---|
| **Path *c*** (direct effect): SES (IV)→Passing Rate (DV) $R^2$ =.195, $F(1,175) = 42.412$, $p<.001$ | -0.442 | -0.804 | .123 | -1.047, -.560 |
| **Path *a*** (direct effect): SES (IV)→Testing Ratio (Med) $R^2 = .167$, $F(1,175) = 35.005$, $p<.001$ | -0.408 | -0.266 | .028 | -.221, -.110 |
| **Path *b*** (direct effect): Testing Ratio (Med)→Passing Rate (DV) $R^2 = .136$ , $F(1,175) = 27.638$, $p<.001$ | 0.369 | 1.655 | .315 | 1.034, 2.277 |
| **Path *c'*** (indirect effect): SES (IV)→ Passing Rate (DV), $p<.001$ | -0.349 | -0.635 | .132 | -.896, -.375 |

# Table 3: Analysis of School Test-Taking Ratio as a Mediator of Physics Mastery Rate

| Testing Path | $\beta$ | *B* | *SE(B)* | 95% CI |
|---|---|---|---|---|
| **Path *c*** (direct effect): SES (IV)→Mastery Rate (DV) $R^2$ =.210, $F(1,175) = 46.496$, $p<.001$ | -0.458 | -0.542 | .080 | -0.699, -.385 |
| **Path *a*** (direct effect): SES (IV)→Testing Ratio (Med) $R^2$ = .167, $F(1,175) = 35.005$, $p<.001$ | -0.408 | -0.266 | .028 | -.221, -.110 |
| **Path *b*** (direct effect): Testing Ratio (Med)→Mastery Rate (DV) $R^2$ = .303 , $F(1,175) = 76.194$, $p<.001$ | 0.551 | 1.605 | .184 | 1.242, 1.968 |
| **Path *c'*** (indirect effect): SES (IV)→ Mastery Rate (DV), $p<.001$ | -0.280 | -0.331 | .078 | -.485, -.177 |

# IMPLICATIONS FOR TEACHING/LEARNING OF SCIENCE

- The results of this study suggest several important implications for physics teachers, science administrators as well as school district administrators.
- Results indicated that in urban schools, passing percentages increased as school-level test-taking ratio increased; in fact, test-taking ratio served to mediate the chronic predictive relationship between SES and student performance.

# IMPLICATIONS FOR TEACHING/LEARNING OF SCIENCE

- Although a school's socioeconomic status was the main predictor of student passing rates in the multivariable model, a school's test-taking ratio was a notable partial mediator.
- By creating an environment where more students are taking more advanced level science courses the overall science culture of the school may change
- Prioritizing physics coursetaking, a school may promote more equitable outcomes for their students. In turn, this would help combat underrepresented minorities in STEM fields and underserved students in general.

# CONTRIBUTION TO INTEREST OF NARST MEMBERS

- By requiring physics for graduation, all students might have equal opportunity to achieve physics competency and literacy.
- Physics teachers, as well as administrators, should support all students taking physics, not just the more advanced students.
- This is particularly important in urban contexts, where students have traditionally experienced restricted access to advanced STEM coursework.