Educational Trajectories in NC

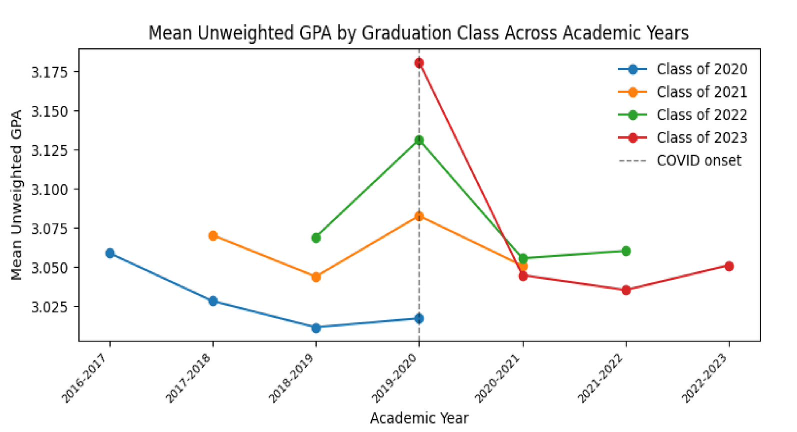
Daniel Matten & Adam Cartwright

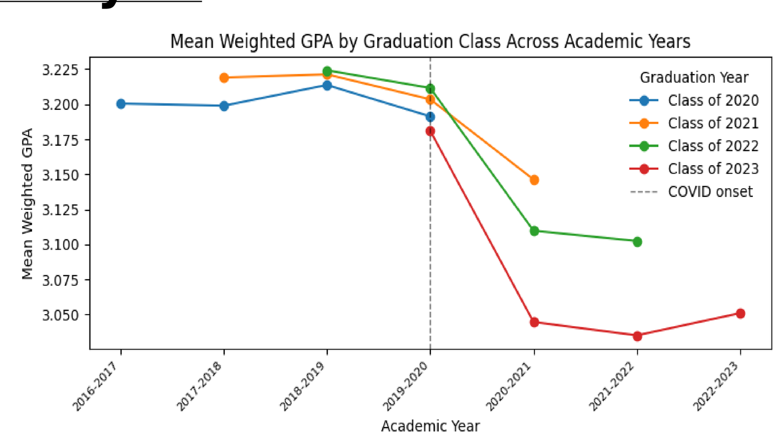
Research Questions

- How did **COVID-19** affect students' GPA and standardized test trajectories?
- How does the **"gifted" label** impact students' middle- and high-school outcomes?
- Are certain trajectories more predictive of high school **dropout**?

Student Trajectories During COVID-19

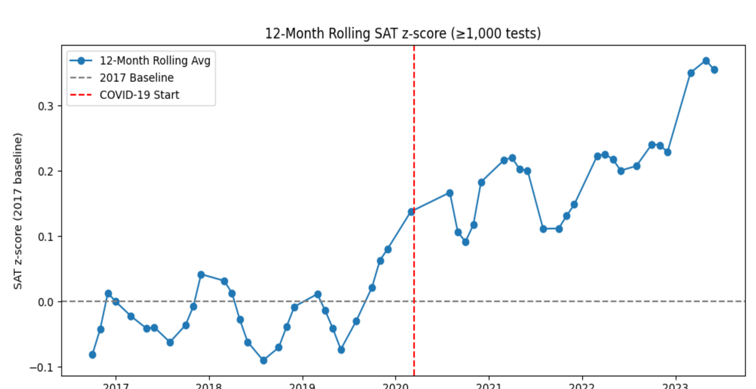
GPA Analysis

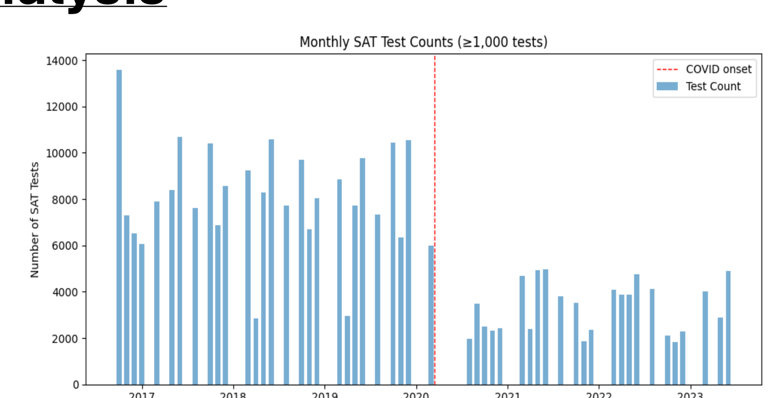




Early-COVID bump: UW GPA rose from 3.04 (18–19) to 3.10 (19–20).
Pandemic decline: Wt GPA fell from 3.20 (19-20) to 3.10 (20-21).
Subgroup gaps: Economically disadvantaged students saw largest drop (−0.079 pts); Academically gifted the smallest (−0.019 pts).
Policy effects: Spring 2020 pass/fail provisions[1] and remote-learning challenges in advanced classes likely contributed to this.

SAT Analysis





SAT z-score jump: Average SAT z-score climbed from –0.011 pre-COVID to +0.250 post-COVID (Δ = 0.261 SD, t = 62.05, $p < .001$).
Participation collapse: Monthly SAT test counts fell by roughly 50–60% after March 2020.
Selection bias: Widespread test-optional policies and reduced stakes meant primarily top-performing students continued to sit the SAT.

Predicting SAT Participation and Reweighted Outcomes:

$$\log\left(\frac{P(Y=1)}{1-P(Y=1)}\right) = \beta_0 + \beta_1\,\mathrm{AIG\_flag} + \beta_2\,\mathrm{EDS\_flag} + \sum_{q=1}^{4}\beta_{PSAT,q}\,\mathrm{PSAT\_Q}_q + \sum_{e}\beta_{Eth,e}\,\mathrm{Ethnicity}_e + \sum_{q=1}^{4}\beta_{GPA,q}\,\mathrm{GPA\_Q}_q$$

	Unweighted (pts)	Weighted (pts)
Pre-COVID mean	1088.7	1033.7
Post-COVID mean	1140.4	1045.2
Gap (Post-Pre)	**51.7**	**11.5**

High-achiever effect: Students in top GPA quartile are about **12×** more likely to take the SAT, and top-quartile PSAT scorers are **4×** more likely.
Equity gaps: Academically gifted students show a boost in testing odds **(13%)**, whereas economically disadvantaged students are **39 % less likely**.
IPTW for adjusted means: Used each student's propensity score (from logistic model) to compute inverse-probability weights, then reweighted the post-COVID test-taker sample to match pre-COVID covariate mix.

Results: At the onset of the pandemic (2019-20), unweighted GPAs ticked upward—likely influenced by lenient grading policies statewide. However, the 2020-21 academic year showed a pronounced decline in weighted GPAs, as remote learning hampered advanced coursework. SAT results tell a more complicated story: although average scores rose after COVID-19, overall test participation collapsed, so most of the apparent gains reflect selection bias.

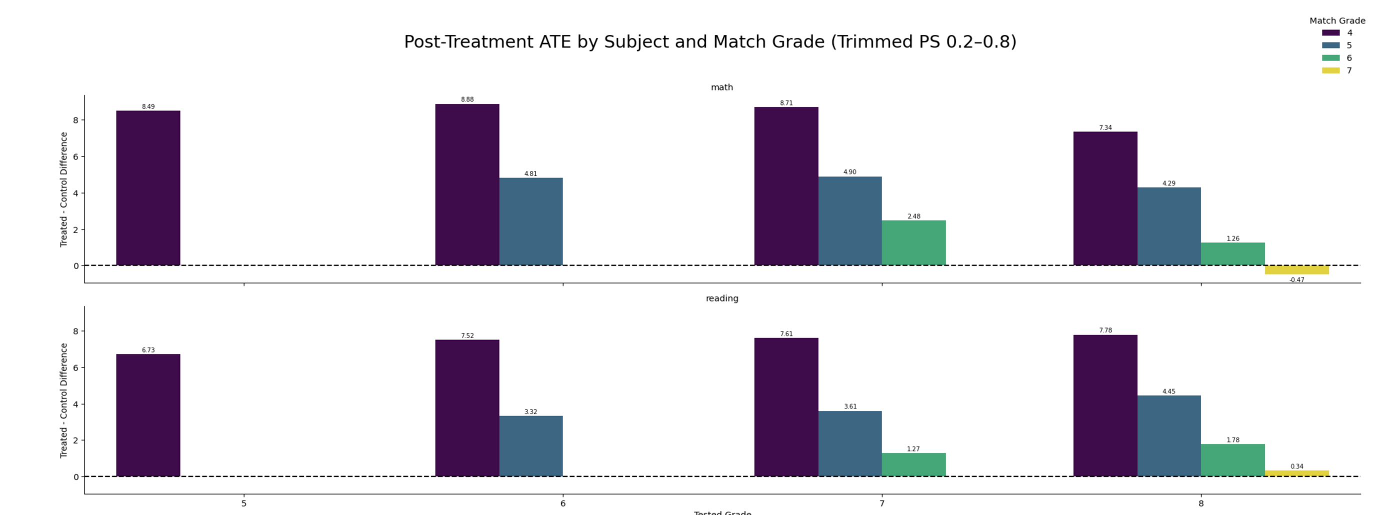
Dataset

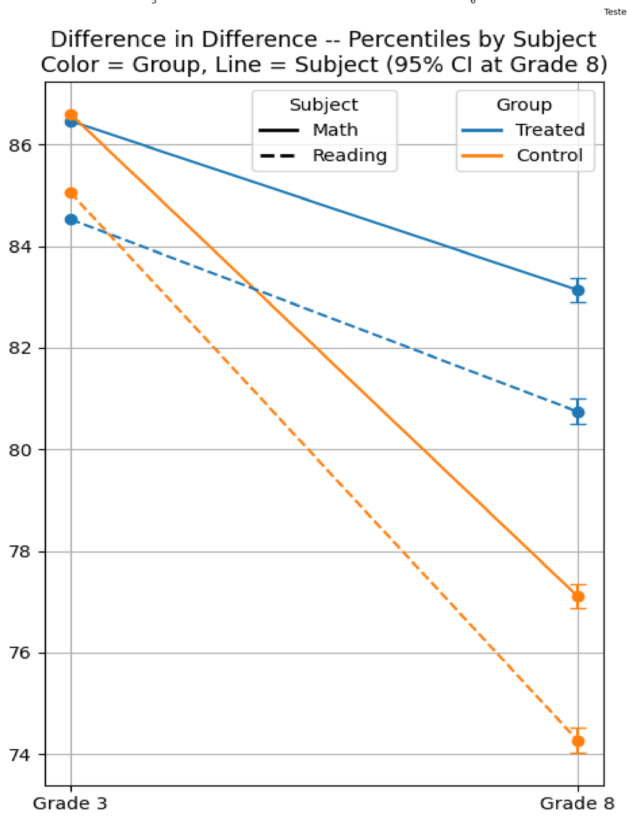
The North Carolina Education Research Data Center (NCERDC) contains **North Carolina public school data** since the 1990s. It is run by the Center for Child and Family Policy at Duke University's Sanford School of Public Policy, who have generously provided us access. The NCERDC contains **longitudinal student data**, including test scores, transcripts, attendance, and demographics for the 1.5 million NC public school students every year.

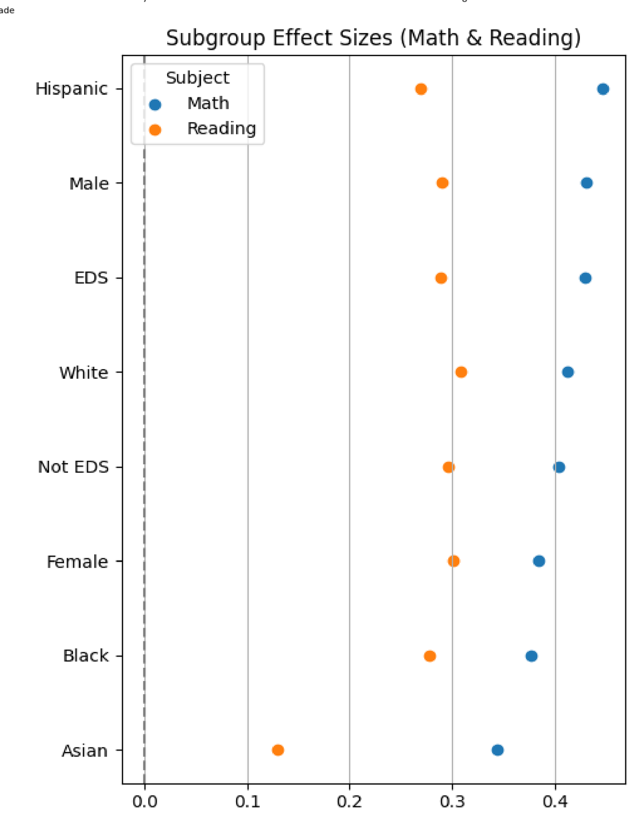
Effect of "Gifted" Label

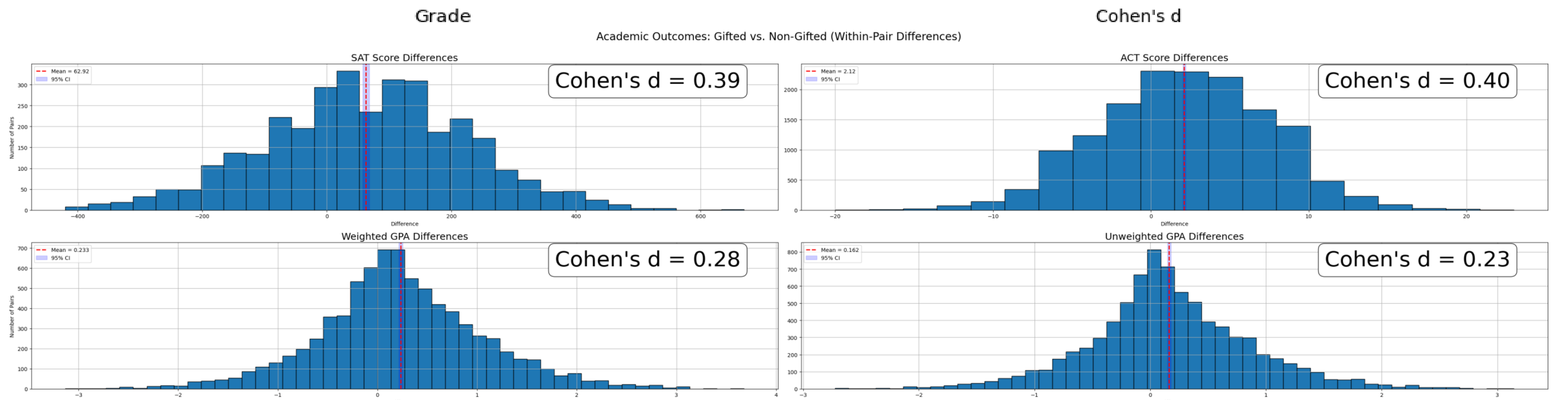
Giftedness: Academically and intellectually gifted (AIG) students are those who demonstrate high performance in academic areas and need specialized educational services beyond the regular curriculum.[2] We aim to **quantify the effect of the AIG label** during a student's academic trajectory.

Causal Inference Study: To simulate a **randomized controlled trial** that controls for factors outside of the AIG tag, we paired students by **propensity score** (likelihood to be gifted, primarily based on test scores) and **similarity score** (based on demographics). This allows us to compare outcomes within a pairing, isolating the effect of giftedness.









Results: The AIG tag results in **moderate but noticeable** effects throughout a child's educational progression. These effects **decrease in math** and **increase in reading**, **remain present in high school**, and **vary demographically**. The initial increase in math performance aligns with the existing literature[3] that link achievement to math self-concept, a measure a student's confidence and self-esteem in a pedagogical setting. Gifted students are pulled out of class to work with other gifted students, reinforcing self-concept and fueling a test score increase. After students learn the foundations of reading, however, a similar self-concept effect is absent,[4] explaining the diminished initial effect in reading. By high school, the gifted curriculum is likely a stronger explanatory factor for the lasting differences between gifted students and their peers.

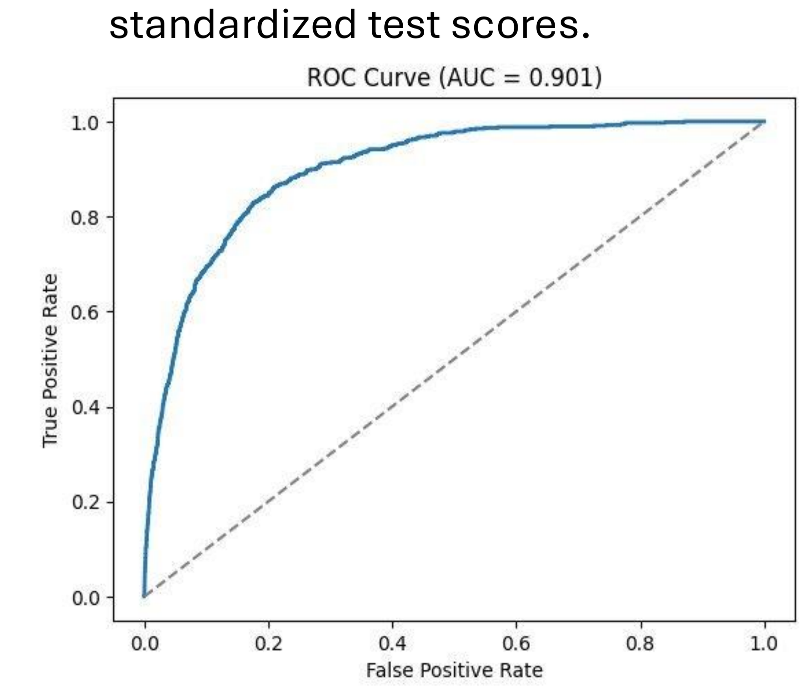
Limitations

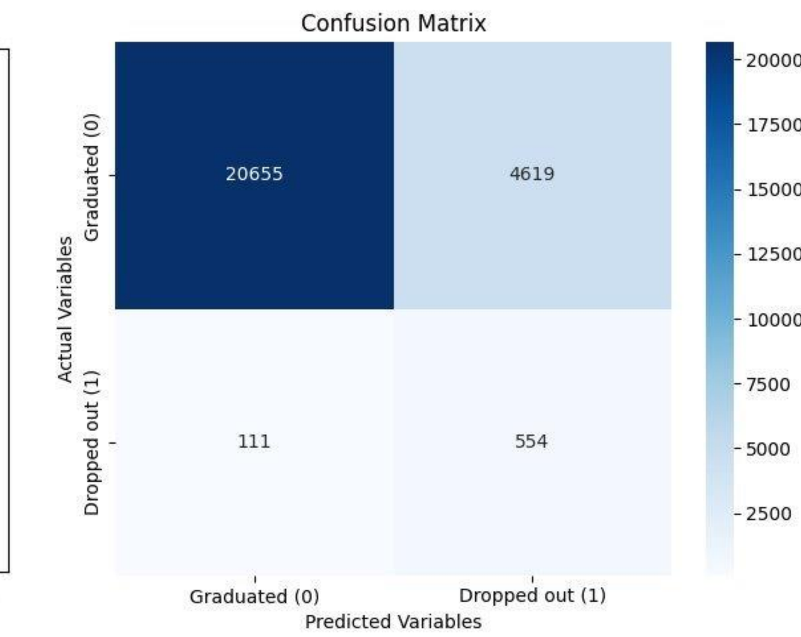
The NCERDC's data is well documented yet inconsistent over time. Standards and definitions inevitably change alongside education policy, so much of our early work involved cleaning, standardizing, and pivoting the historic data to produce accurate, filled-in, longitudinal records. Additionally, data from 2020 is occasionally missing due to the limitations imposed by the COVID-19 pandemic.

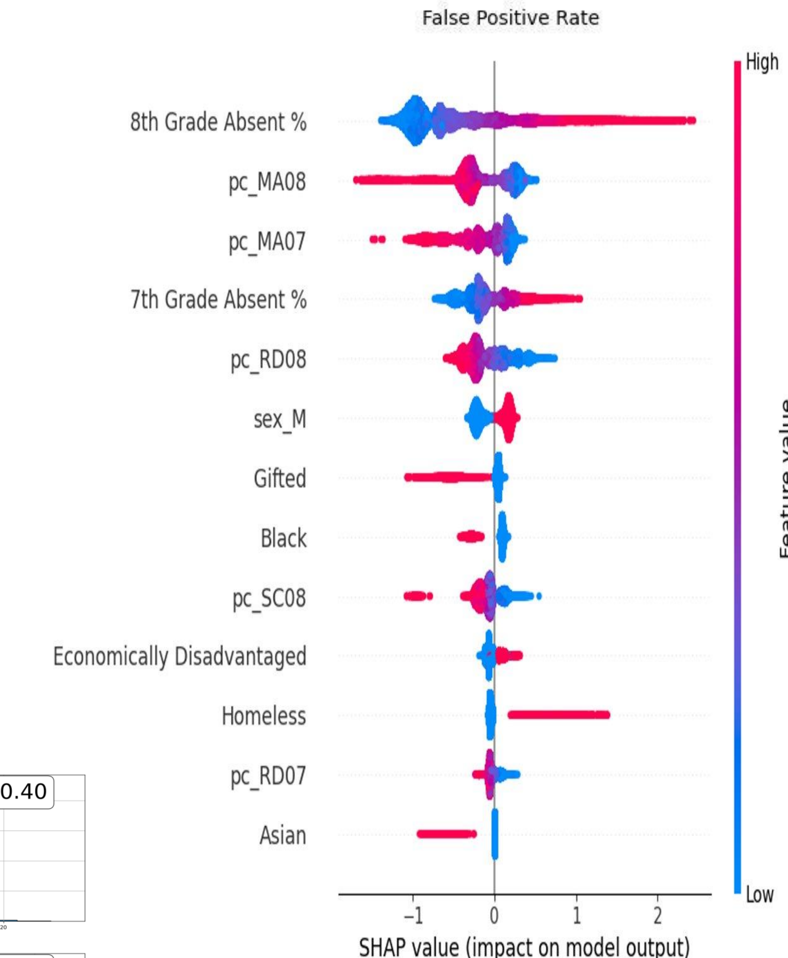
Predicting High School Dropout

Goal: We aim to identify the key predictors of high school dropout to enable the Department of Public Instruction and school districts to implement targeted interventions for at-risk students. About 3%, or 7756 out of 300,000 students in this sample, dropped out of high school.

Model: To enhance model interpretability, we employed gradient-boosted decision trees using XGBoost to predict student dropout and determine the most influential predictors. Input variables included Local Enforcement Agency (LEA), demographic data, and 3rd-8th grade attendance and standardized test scores.







Performance: Although the model achieves a high AUC of 0.901, it performs poorly in classifying the minority dropout class, which is expected due to the extreme class imbalance in the data. Nevertheless, for policy applications, this limitation may be acceptable. Overpredicting dropout can be advantageous if it enables timely interventions in potential dropout cases.

Results: The metrics most strongly associated with high school dropout are **attendance** and **math scores**, with indicators from later grade levels demonstrating greater predictive importance. **Gifted** students are less likely to drop out, while **economically disadvantaged** students are more likely to do so.

Acknowledgements & References

We would like to thank Ramil Mammadov, Dr. Jennifer Lansford, Matthew Edwards, and Kevin Shropshire for their unwavering support.

----

[1] North Carolina Department of Public Instruction. (2020, April). State Board Approves Year-End Grading Policy, Other COVID-19-Related Measures. www.dpi.nc.gov/news/press-releases/2020/04/23/state-board-approves-year-end-grading-policy-other-covid-19-related-measures

[2] North Carolina Department of Public Instruction. (2024, July). *North Carolina academically or intellectually gifted (AIG) program standards* (State Board of Education Policy ACIG-000). https://www.dpi.nc.gov/2024-nc-aig-program-standards/download?attachment

[3] Kaskens, J., Segers, E., Goei, S. L., & van Luit, J. E. H. (2020). Impact of children's math self-concept, math self-efficacy, math anxiety, and teacher competencies on math development. *Teaching and Teacher Education, 94*, 103096. https://doi.org/10.1016/j.tate.2020.103096

[4] Chapman, J. W., & Tunmer, W. E. (1997). A longitudinal study of beginning reading achievement and reading self-concept. *British Journal of Educational Psychology*, 67(3), 279-291. https://doi.org/10.1017/S136064179837166X