

ICFES Referrals

20-minute internal presentation for data analysis

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Selection into the experiment

- Better students self select
- Low and High SES self select

	Admin Data	Sample	p
Reading score	62.651	65.183	< 0.001
Math score	63.973	67.477	< 0.001
GPA	3.958	4.012	< 0.001
Low-SES	0.343	0.410	< 0.001
Med-SES	0.505	0.499	0.763
High-SES	0.153	0.091	< 0.001
Observations	4,417	734	5,151

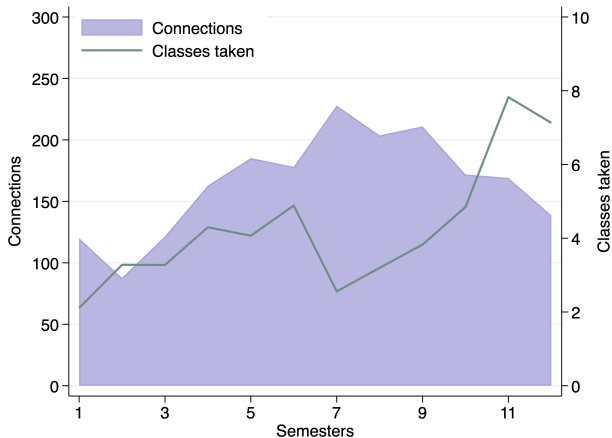
Balance between treatments

- Successful randomization

	Baseline	Bonus	p
Reading score	64.712	65.693	0.134
Math score	67.366	67.597	0.780
GPA	4.003	4.021	0.445
# connections	173.40	176.88	0.574
Tie strength	3.939	3.719	0.443
Low-SES	0.419	0.401	0.615
Med-SES	0.492	0.506	0.714
High-SES	0.089	0.094	0.824
Observations	382	352	734

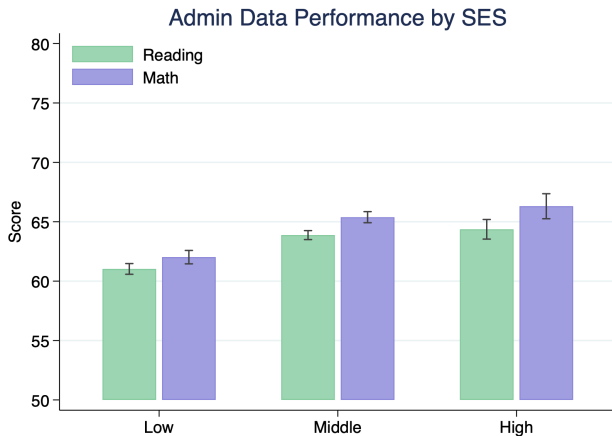
Network size and tie strength by semester

- Classes taken together increases over time
- Connections peak around 7 semesters and decline as students graduate



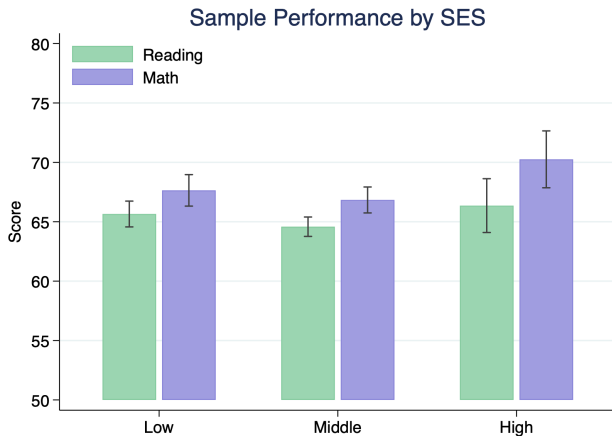
Admin data performance by SES

- Performance increases with SES across math and reading



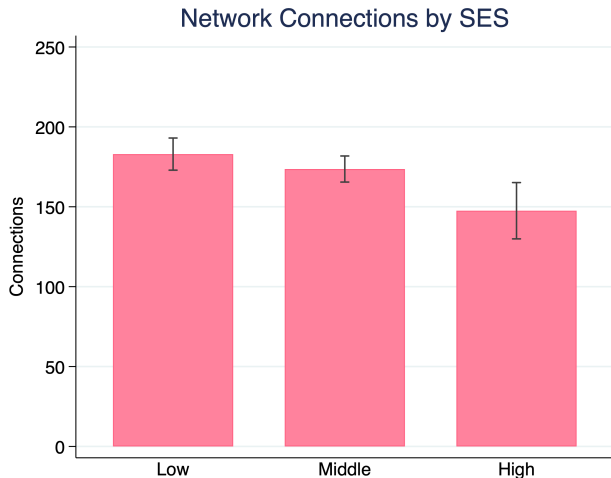
Sample performance by SES

- Similar SES performance across math and reading



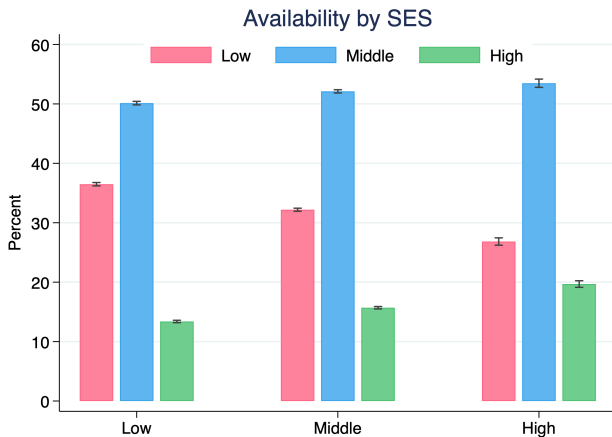
Network connections by SES

- Small monotonic decrease in connections across SES



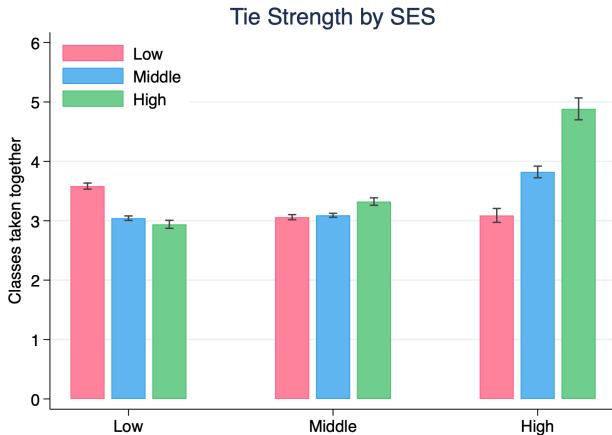
Network composition by SES

- Monotonic increase in availability across SES
- All differences are statistically significant ($p < 0.001$)



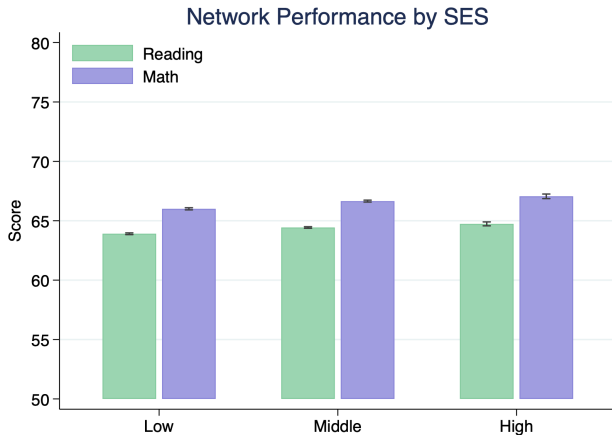
Network tie strength by SES

- Low and High SES take more classes with their own



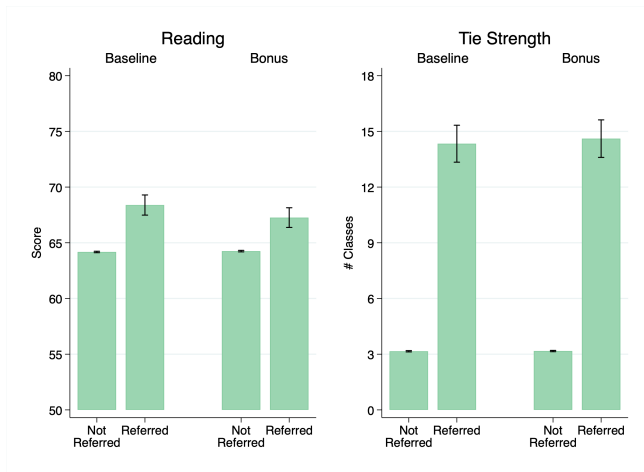
Network performance by SES

- Similar SES performance across math and reading



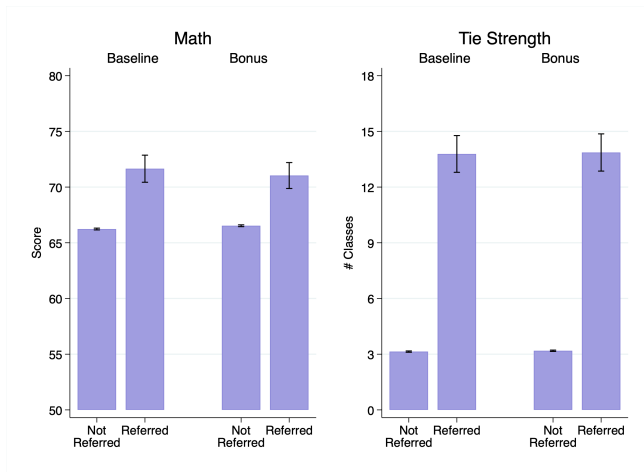
Referrals for Reading

- Referrals have higher reading scores and much higher tie strength
- No treatment effect on the referred for reading score or for tie strength (all $p > 0.08$)

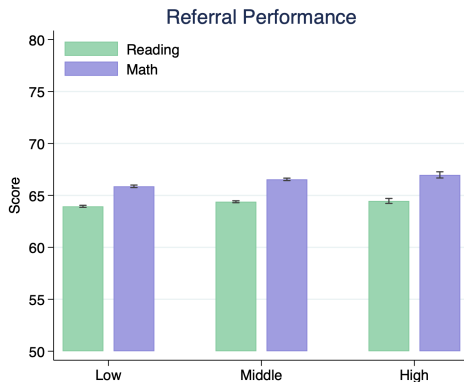
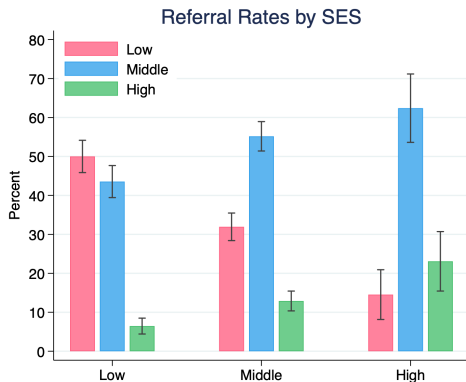


Referrals for Math

- Referrals have higher math scores and much higher tie strength
- No treatment effect on the referred for math score or for tie strength (all $p > 0.1$)



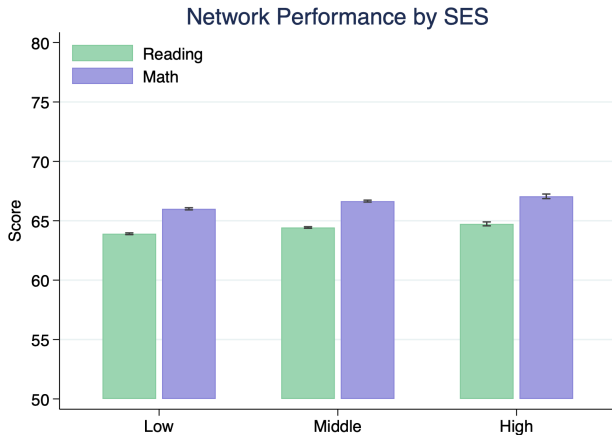
Referral distribution and performance by SES



- Large monotonic differences in referral shares as SES increases (all $p < 0.1$)
- Small differences in math and reading performance across SES (all $p > 0.08$)

Referral tie strength

- Similar SES performance across math and reading



Regression Analysis

Empirical specification: referral choice

- Model the referral choice using a mixed multinomial logit model for each referrer's choice set (average 175 potential nominees) [McFadden and Train, 2000]
- The probability that student i refers student $j \in N_i$ is given by

$$\frac{e^{\beta_i x_{ij}}}{\sum_{j=1}^{N_i} e^{\beta_i x_{ij}}}$$

where x_{ij} is the vector of characteristics of j (low-SES, test score, tie strength) and β_i is a vector of individual-specific parameters comprising of a constant and a random component

Is there a Low-SES bias in Reading referrals?

- Reading score and tie strength are strong predictors of referrals
- No interaction between reading score and tie strength
- No evidence for a Low-SES bias in referrals when controlling for referral score and tie strength

	(1)	(2)	(3)
Low-SES	0.199** (0.083)	0.041 (0.100)	0.042 (0.100)
Reading Score		0.561*** (0.044)	0.509*** (0.048)
Tie		0.951*** (0.031)	0.941*** (0.032)
Score x Tie			0.029 (0.018)
Observations	128,847	128,847	128,847
Individuals	673	673	673

Is there a Low-SES bias in Math referrals?

- Math score and tie strength are strong predictors of referrals
- Significant but small interaction between math score and tie strength
- No evidence for a Low-SES bias in referrals when controlling for referral score and tie strength

	(1)	(2)	(3)
Low-SES	0.220*** (0.083)	0.049 (0.097)	0.050 (0.098)
Math Score		0.653*** (0.040)	0.538*** (0.041)
Tie		0.887*** (0.029)	0.854*** (0.030)
Score x Tie			0.088*** (0.019)
Observations	128,150	128,150	128,150
Individuals	669	669	669

Do grades predict Reading referrals?

- GPA correlates weakly with reading score ($\rho = 0.18$)
- GPA is a better predictor of referrals when controlling for reading score and tie strength

	(1)	(2)	(4)
GPA	0.759*** (0.044)	0.640*** (0.059)	0.578*** (0.070)
Reading Score		0.407*** (0.048)	0.344*** (0.068)
Tie Strength		0.936*** (0.031)	0.911*** (0.032)
Score \times Tie			0.010 (0.022)
Score \times GPA			0.017 (0.056)
GPA \times Tie			0.028 (0.026)
Score \times Tie \times GPA			0.030* (0.018)

Do grades predict Math referrals?

- Significant but small interactions between tie strength and both performance variables
- GPA correlates weakly with math score ($\rho = 0.14$)
- GPA is a better predictor of referrals when controlling for math score and tie strength

	(1)	(2)	(4)
GPA	0.765*** (0.044)	0.621*** (0.059)	0.500*** (0.068)
Math Score		0.531*** (0.044)	0.400*** (0.065)
Tie Strength		0.871*** (0.029)	0.808*** (0.030)
Score \times Tie			0.068*** (0.023)
Score \times GPA			0.026 (0.061)
GPA \times Tie			0.069*** (0.026)
Score \times Tie \times GPA			0.034 (0.022)

Is there in-group homophily in Reading referrals?

- Restrict sample by SES of referrer
- Define homophily as same SES referrer-nominee dyad
- Only Low-SES exhibit homophily for other Low-SES

	Low-SES (1)	Med-SES (2)	High-SES (3)
Homophily	0.300** (0.152)	0.203 (0.125)	-0.354 (0.344)
Reading Score	0.433*** (0.074)	0.353*** (0.067)	0.674*** (0.170)
Tie	0.860*** (0.043)	0.991*** (0.048)	1.061*** (0.134)
GPA	0.648*** (0.094)	0.667*** (0.081)	0.477** (0.228)
Observations	54,611	64,596	9,640
Individuals	275	340	58

Is there in-group homophily in Math referrals?

- Restrict sample by SES of referrer
- Define homophily as same SES referrer-nominee dyad
- Only Low-SES exhibit homophily for other Low-SES

	Low-SES (1)	Med-SES (2)	High-SES (3)
Homophily	0.282* (0.146)	0.161 (0.125)	-0.030 (0.358)
Math Score	0.500*** (0.069)	0.516*** (0.064)	0.810*** (0.128)
Tie	0.823*** (0.040)	0.892*** (0.044)	1.046*** (0.141)
GPA	0.580*** (0.093)	0.675*** (0.083)	0.519** (0.219)
Observations	55,531	62,492	10,127
Individuals	283	327	59

Empirical Specification: referral performance

OLS Model:

$$\text{Score}_{ij} = \beta_0 + \beta_1 \cdot X_i + \beta_2 \cdot \text{Mean Score}_j + \beta_3 \cdot \text{SD Score}_j + \varepsilon_{ij}$$

- Score_{ij} : Test score of the nominee from referrer i in subject j
- X_{ij} : SES of student i or the test score of student i in subject j
- Mean Score_j and SD Score_j : Mean and SD of i 's network performance in subject j

Features:

- Sample restricted to nominated students only
- Controls for network-level performance differences
- Standard errors clustered at individual level

Do Low-SES refer better?

- No evidence that Low-SES refer better in reading or math
- Better referrals depend on average network performance

	Reading (1)	Math (2)
Med-SES	-1.213** (0.607)	-0.816 (0.731)
High-SES	0.438 (1.085)	0.937 (1.287)
Mean Score	1.250*** (0.096)	1.399*** (0.074)
SD Score	0.233 (0.409)	0.163 (0.318)
Constant	-13.062 (8.006)	-21.571*** (6.373)
Observations	673	669

Is there performance homophily in referrals?

- Significant but small effect of own test score on referral score
- Very large difference between the average network test score versus referrer performance (about 6 times)
- Performance homophily is nearly not as important as network composition

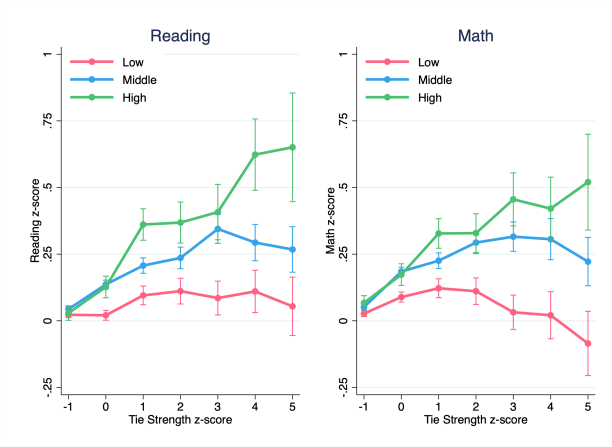
	Reading (1)	Math (2)
Own Score	0.177*** (0.035)	0.176*** (0.036)
Mean Score	1.020*** (0.101)	1.186*** (0.082)
SD Score	0.056 (0.398)	0.155 (0.310)
Constant	-9.126 (7.835)	-19.835*** (6.240)
Observations	673	669

Summary

- No evidence for a Low-SES bias in referrals
- Referrers pick nominees based on performance and tie strength
- Referral performance depends heavily on referrer network composition

Prelude

- Which SES group has the better network?
- Are Low-SES restrained w.r.t. their network referral choice set?



Empirical Specification: network performance

OLS Model:

$$\text{Mean Score}_{ij} = \beta_0 + \beta_1 \cdot \text{Score}_{ij} + \beta_2 \cdot \text{Low-SES}_i + \varepsilon_{ij}$$

- Mean Score_{ij} : Average network test score of referrer i in subject j
- Score_{ij} : Test score of referrer i in subject j
- Low-SES_i : Referrer i is Low-SES

Features:

- Sample restricted to referrers only
- Estimated at relevant tie-strength z-score thresholds ($z_{\text{tie}} \geq 0, 1, 2, 3$)
- Standard errors clustered at individual level

Do Low-SES have worse networks in Reading?

- Average referral tie strength is around 2.7 SD for reading scores
- Referrer reading score has a significant effect at thresholds [0, 2]
- Higher SES referrers have better networks across thresholds

	Tie ≥ 0 (1)	Tie ≥ 1 (2)	Tie ≥ 2 (3)	Tie ≥ 3 (4)
Score reading	0.212*** (0.017)	0.233*** (0.020)	0.245*** (0.024)	0.313*** (0.029)
Low-SES	-1.295*** (0.304)	-0.777** (0.358)	-0.891** (0.427)	-0.589 (0.517)
Constant	50.629*** (1.124)	49.356*** (1.321)	48.777*** (1.557)	44.443*** (1.953)
Observations	673	651	560	471

Do Low-SES have worse networks in Math?

- Average referral tie strength is around 2.5 SD for math
- Referrer math score has a significant but small effect at each tie strength threshold
- Higher SES referrers have much better networks at each tie strength threshold

	Tie \geq 0 (1)	Tie \geq 1 (2)	Tie \geq 2 (3)	Tie \geq 3 (4)
Score math	0.333*** (0.019)	0.356*** (0.022)	0.395*** (0.025)	0.391*** (0.032)
Low-SES	-1.847*** (0.428)	-1.343*** (0.478)	-1.122** (0.560)	-1.321** (0.653)
Constant	44.215*** (1.326)	42.696*** (1.490)	40.197*** (1.756)	40.698*** (2.195)
Observations	669	648	559	464

Conclusion

- Referrers pick nominees based on performance and tie strength
- Referral performance depends heavily on referrer network composition
- No evidence for a Low-SES bias in referrals
- Network inequality may constrain Low-SES referral choices