# Exploring the association between the Noyce Scholarship Program and Public-School Districts with Spatial Patterns in the U.S

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## Research Summary

### Background

The Robert Noyce Teacher Scholarship Program (RNTSP) provides financial support to undergraduate students who are interested in pursuing a career in teaching STEM subjects. However, there are some challenges associated with estimating the effectiveness of this program. These challenges include time lag, spatial non-synergistic effects, and the lack of an object-based surveillance mechanism. These factors contribute to uncertainties in the estimation of the program's impact.

### Research Purpose

This research aims to identify the spatial relationship between RNTSP and public-school districts in the U.S. The main objective is to examine the potential effects of RNTSP on the current public school system. This will be achieved by the use of the spatial join tool. Specifically, different radii intersections will be used to determine the extent of the relationship between RNTSP and the public-school districts. By doing so, the research will provide valuable insights into the effectiveness of RNTSP and how it impacts the education resources available to public schools.

### Research Questions

How does the RNTSP influence public school districts in the U.S. in space?

## Data

### Data Source

We used education demographic and geographic estimates (EDGE) from the National Center for Education Statistics (NCES). The study year was 2019 because most RNTSP implementation occurred before 2019. The study sample was 952 Noyce programs that were covered by 12833 public elementary and secondary school districts.

### The Dependent Variable

After roughly calculating the distance between the Noyce program and the school districts. We determined 10 miles and 25 miles as search radii to create buffer zones. Then we defined two distance variables such as SP10 and SP25 (i.e., "0" as “fail to join", and "1" as “join successfully").

### The Independent Variables

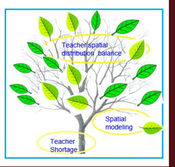
We collected 18 explanatory variables in 12833 school districts, including the percent of totally free and reduced lunches, the percentage of reduced lunches, urban area, the percentage of school administrators, school district staff, the percentage of the school district administrator, the percentage of librarians, the percent of school staff, the percent of teachers, the percentage of teachers from PreK to the secondary, counselor, special education students, the percentage of students.

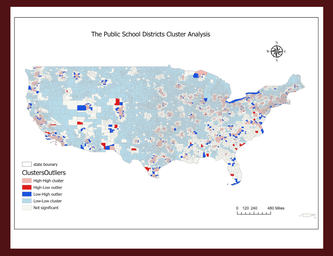
## System’s Thinking

To examine how well the Noyce program supports STEM teachers, we took advantage of the strengths of spatial models to examine the distribution of the Noyce program, matching U.S. public school districts with a spatial join of 10 or 25 miles and then conducted OLS, SLR, and SER models to uncover spatial dependence and heterogeneity. It provided robust evidence for evaluating teacher incentives and compensation, valuable insights for education policymakers, and a new perspective on addressing teacher location-allocation.

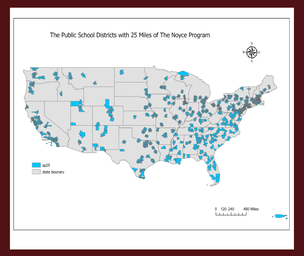
### Research Procedure

- Create two buffers with radii of 10 miles and 25 miles.
- Create a spatially weighted matrix.
- Develop an ordinary least squares model
- Develop spatial models (SER & SLR).
- Demonstrate statistical significance.
- Evaluate statistical significance.



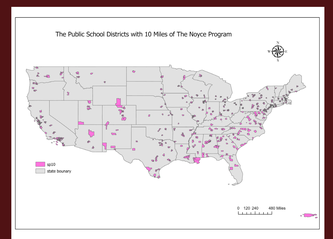



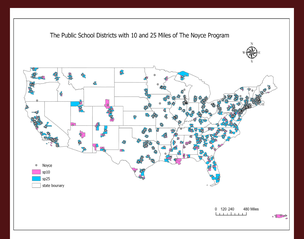

*The Public-School Districts Cluster Analysis*



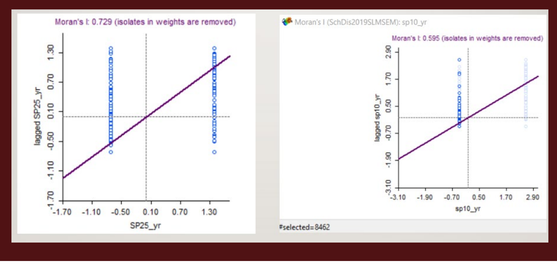

*This is the public-school districts distribution map around the Noyce program with 25 miles intersections of spatial join.*

*This is the public school district distribution map around the Noyce program with 10 miles of intersections of spatial join.*

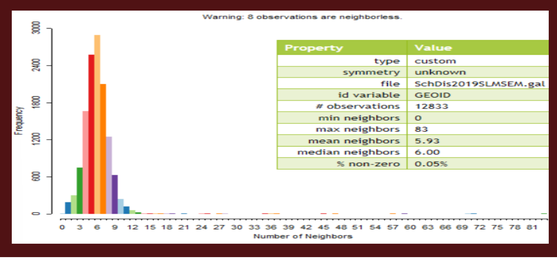



*This is the public school district's map around the Noyce program with 10 miles and 25-mile intersections of spatial join.*




*The Moran I indexes with radii of 10 miles and 25 miles.*




*The Spatial Connectivity is shown that 8 public school districts have no neighbors.*

## Results

### OLS and SLR

| Variable | Ordinary Least Square | | | | Spatial Lag Regression Model | | | |
|---|---|---|---|---|---|---|---|---|
| | Coef. | Std.Error | t-Statistic | p-value | Coef. | Std.Error | Z-Value | p-value |
| W_SP25_yr | | | | | 0.871 | 0.005 | 183.732 | 0.000 |
| CONSTANT | 0.92579 | 0.01399 | 66.190 | 0.00000 | 0.13693 | 0.00858 | 15.95410 | 0.00000 |
| d_p_frlch | -0.16723 | 0.01564 | -10.695 | 0.00000 | -0.04252 | 0.00876 | -4.85627 | 0.00000 |
| d_p_redu | -0.59881 | 0.08360 | -7.163 | 0.00000 | -0.00116 | 0.04658 | -0.02501 | 0.98005 |
| urban_cent | -0.01494 | 0.00038 | -38.948 | 0.00000 | -0.00244 | 0.00022 | -11.19090 | 0.00000 |
| school_adm | -0.00034 | 0.00035 | -0.961 | 0.33676 | -0.00018 | 0.00019 | -0.94231 | 0.34603 |
| lea_staff_ | 0.00020 | 0.00017 | 1.201 | 0.22979 | 0.00005 | 0.00009 | 0.58222 | 0.56042 |
| lea_admin_ | 0.00008 | 0.00024 | 0.347 | 0.72912 | -0.00008 | 0.00013 | -0.62523 | 0.53182 |
| librarian_ | -0.00196 | 0.00077 | -2.561 | 0.01044 | 0.00036 | 0.00043 | 0.85550 | 0.39227 |
| teachers_t | -0.00037 | 0.00008 | -4.757 | 0.00000 | -0.00015 | 0.00004 | -3.44274 | 0.00058 |
| teachers_s | 0.00039 | 0.00010 | 3.917 | 0.00009 | 0.00017 | 0.00006 | 3.00747 | 0.00263 |
| guidance_c | -0.00322 | 0.00087 | -3.721 | 0.00020 | -0.00038 | 0.00048 | -0.78079 | 0.43493 |
| teachers_e | 0.00050 | 0.00009 | 5.869 | 0.00000 | 0.00018 | 0.00005 | 3.83608 | 0.00013 |
| spec_ed_st | 0.00001 | 0.00000 | 3.284 | 0.00103 | 0.00000 | 0.00000 | 1.13591 | 0.25599 |
| teachers_p | 0.00009 | 0.00034 | 0.259 | 0.79544 | 0.00004 | 0.00019 | 0.22298 | 0.82355 |
| teachers_k | 0.00015 | 0.00024 | 0.613 | 0.53986 | 0.00011 | 0.00013 | 0.82555 | 0.40906 |
| guidance_2 | 0.00015 | 0.00071 | 0.205 | 0.83760 | 0.00020 | 0.00040 | 0.51344 | 0.60764 |
| school_sta | -0.00002 | 0.00005 | -0.348 | 0.72830 | -0.00002 | 0.00003 | -0.71628 | 0.47382 |
| staff_tota | 0.00005 | 0.00002 | 2.534 | 0.01129 | 0.00002 | 0.00001 | 2.16336 | 0.03051 |
| R-square | | 0.197 | | | | 0.75 | | |

- In 25 miles buffer zone, the percentage of the free lunch program was negatively significant.
- In 25 miles buffer zone, the urban area is negatively significant.

## Results

### OLS and SER

| Variable | Ordinary Least Square | | | | Spatial Error Regression Model | | | |
|---|---|---|---|---|---|---|---|---|
| | Coef. | Std.Error | t-Statistic | P-value | Coef. | Std.Error | Z-Value | P-value |
| CONSTANT | 0.92579 | 0.01399 | 66.190 | 0.0000 | 0.3861 | 0.0228 | 16.923 | 0.0000 |
| d_p_frlch | -0.16723 | 0.01564 | -10.695 | 0.0000 | -0.0273 | 0.0119 | -2.299 | 0.0215 |
| d_p_redu | -0.59881 | 0.08360 | -7.163 | 0.0000 | 0.1310 | 0.0568 | 2.307 | 0.0210 |
| urban_cent | -0.01494 | 0.00038 | -38.948 | 0.0000 | -0.0003 | 0.0003 | -1.003 | 0.3159 |
| school_adm | -0.00034 | 0.00035 | -0.961 | 0.3368 | 0.0001 | 0.0002 | 0.661 | 0.5086 |
| lea_staff_ | 0.00020 | 0.00017 | 1.201 | 0.2298 | 0.0000 | 0.0001 | 0.490 | 0.6238 |
| lea_admin_ | 0.00008 | 0.00024 | 0.347 | 0.7291 | -0.0003 | 0.0001 | -2.358 | 0.0184 |
| librarian_ | -0.00196 | 0.00077 | -2.561 | 0.0104 | 0.0011 | 0.0004 | 2.617 | 0.0089 |
| teachers_t | -0.00037 | 0.00008 | -4.757 | 0.0000 | -0.0001 | 0.0000 | -2.511 | 0.0120 |
| teachers_s | 0.00039 | 0.00010 | 3.917 | 0.0001 | 0.0002 | 0.0001 | 2.916 | 0.0035 |
| guidance_c | -0.00322 | 0.00087 | -3.721 | 0.0002 | 0.0011 | 0.0005 | 2.203 | 0.0276 |
| teachers_e | 0.00050 | 0.00009 | 5.869 | 0.0000 | 0.0001 | 0.0000 | 1.323 | 0.1857 |
| spec_ed_st | 0.00001 | 0.00000 | 3.284 | 0.0010 | 0.0000 | 0.0000 | -0.900 | 0.3682 |
| teachers_p | 0.00009 | 0.00034 | 0.259 | 0.7954 | -0.0003 | 0.0002 | -1.825 | 0.0681 |
| teachers_k | 0.00015 | 0.00024 | 0.613 | 0.5399 | 0.0001 | 0.0001 | 0.766 | 0.4436 |
| guidance_2 | 0.00015 | 0.00071 | 0.205 | 0.8376 | -0.0003 | 0.0004 | -0.832 | 0.4054 |
| school_sta | -0.00002 | 0.00005 | -0.348 | 0.7283 | 0.0000 | 0.0000 | -0.753 | 0.4515 |
| staff_tota | 0.00005 | 0.00002 | 2.534 | 0.0113 | 0.0000 | 0.0000 | 3.282 | 0.0010 |
| LAMBDA | | | | | 0.9004 | 0.0043 | 207.124 | 0.0000 |
| R-square | | 0.197 | | | | 0.751 | | |

The SER model is shown that RNTSP was spatially dependent on school districts. The percentages of the free lunch program were significant in a 25 miles buffer zone.

## Conclusion

In the 25 miles buffer zone, the RNTSP influenced public school districts in the U.S. in terms of the percentage of the free lunch program, the total number of teachers, and the total number of staff according to the SLR and SER model.

## References

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Milgrom-Elcott, T. (2022, March 23). Rising to the challenge of providing all students with high-quality STEM education. Brown Center Chalkboard.

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