Title:
A Longitudinal Study of the Impact of Attending an Inclusive STEM High School: The Case for Using Two Comparison Groups

Authors and Affiliations:
Haiwen Wang,[1] Barbara Means,[2] Viki Young,[1] and Ann House [1]
[1] SRI Education
[2] Digital Promise

Abstract Body

Background / Context: Policymakers argue that only by enlarging the STEM (science, technology, engineering, and mathematics) pipeline in a way that attracts, supports, and sustains the participation of students from all kinds of backgrounds can the United States meet its needs for science and technology innovation, economic prosperity, and social well-being (National Academies, 2005). To meet this need, inclusive STEM high schools (ISHSs) combine rich STEM course offerings and experiences with an explicit mission to serve students from under-represented groups accepted on the basis of interest rather than competitive examination.

Evidence regarding the impact of STEM schools is just starting to emerge. A value-added analysis of 2006-09 STEM outcomes data from North Carolina and Florida middle and high schools by Hansen (2013) reported no advantage for STEM-focused schools. On the other hand, Young et al. (2011) found small impacts on math and science test scores for T-STEM high school students in Texas. Wiswall et al. (2014) found an advantage of STEM school seniors over their counterparts in non-STEM schools in terms of STEM course-taking and Regents exam scores. Furthermore, Means et al. (2017) found positive relationships between ISHS attendance and academic achievement, STEM course-taking, goals, identity, and expectations in North Carolina and Texas.

One of the distinctive features of the present ISHS study is that it provides a comprehensive picture of the impact of ISHSs by using two sets of comparison groups: schools in the same districts as the ISHSs to control for local context; and comparable schools in districts with no access to STEM schools to alleviate potential bias caused by student self-selection into ISHSs. The two comparisons validate each other in providing solid evidence regarding the impact of ISHSs.

Purpose / Objective / Research Question / Focus of Study: This study addresses the following research questions:

1. Do students attending ISHSs differ from students in other same-district high schools in terms of demographic characteristics and middle school achievement?

2. Is there evidence of an impact of ISHS attendance on students' persistence to 12th grade, high school graduation, and college readiness and aspirations?

Population / Participants / Subjects: We researched all possible ISHS schools in North Carolina with a significant proportion of low income and/or minority students (35% or more). We conducted phone calls to each candidate school to screen out those that were not truly ISHSs, and finally identified a sample of 19 ISHSs.

For each of these 19 ISHSs, we identified two comparison schools similar in the demographics of their students from districts without any ISHSs, creating a group of 38 out-of-district comparison schools. We also took all eligible high schools in the same districts with the ISHSs, yielding 89 within-district comparison schools.

Intervention / Program / Practice: Many different types of inclusive STEM schools are being established. Some focus on specific occupations and provide extensive mentoring and internship opportunities; some stress integration of STEM subjects and project-based learning; and others structure their courses more traditionally and emphasize opportunities to take college-level courses (Lynch et al., 2014; Means et al., 2008; Young et al., 2011). The ISHSs included in the present study were a mix of these different types.

Research Design: As described previously, this study compares ISHS student outcomes with those from both within- and out-of-district comparison groups to detect convergence on the impact of ISHSs on student outcomes. For each set of comparisons, we applied propensity score weighting using a rich set of covariates to adjust for differences between ISHS and comparison schools in student and school characteristics.

Data Collection and Analysis: We obtained state longitudinal student data from North Carolina Education Research Data Center for 2012-13 12th-grade students. The data provide high school outcome indicators, including a college aspiration indictor from a statewide survey, and student demographic and 8th-grade achievement data and academic experience indicators.

Using propensity score weighting, we posited a multilevel model with student and school levels for each outcome, with ISHS impact estimated at the school level. The model included as covariates school- and student-level covariates presented in Table 1 and Table 2.

(Insert Table 1 and Table 2 here)

Findings / Results: Table 1 describes school characteristics for ISHS and within- and out-of-district comparison groups respectively. ISHSs served higher proportions of economically needy and minority students than both within- and out-of-district comparison schools, and were also more likely than the within-district comparison group to be Title I schools.

Table 2 presents student demographic and prior academic achievement and experience indicators for ISHS students and their counterparts in comparison schools, both before and after propensity score weighting. Compared with students in other schools in the same district, ISHS students were more likely to be African American and from low-income backgrounds and had slightly lower scores on nearly all the available grade 8 academic achievement measures. As expected, after propensity score weighting, there were no statistically significant differences for any of these measures.

Table 3 and Table 4 present the ISHS impact estimates for within- and out-of-district comparisons, respectively. The results from the two sets of comparisons are consistent: both suggest that 9th-grade ISHS students were more likely to persist to 12th grade, earn a high school diploma, take ACT/SAT, and plan to attend a college than comparison students.[*]

(Insert Table 3 and Table 4 here)

Conclusions:

Our data indicate that North Carolina ISHSs served a diverse set of students. Compared with students in the same districts, ISHS students had slightly lower incoming academic achievement and were more likely to be African American and to come from low-income households.

Within- and out-of-district comparisons provide consistent findings on the impact of ISHS attendance. ISHS attendance appears to have a positive impact on students' persistence to 12th grade, high school graduation, and college readiness and aspirations.

Appendices

[*]This analysis considered students who did not persist to 12th grade as not college-ready. We conducted an additional analysis using only students who persisted to 12th grade. In this analysis, there were no statistically significant differences between ISHS and comparison school students in the likelihood of taking ACT/SAT or intention to enroll in a 4-year college or a 2- or 4-year college.

Appendix A. References

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Appendix B. Tables and Figures

Table 1
Average School Characteristics for ISHS and Comparison Groups

School characteristics	ISHS (n=19)	Within-district Comparison (n=89)	Out-of-district Comparison (n=38)
Title I status	0.95	0.61	0.97
Percent needy	57.66	46.78	52.94
Percent minority	65.58	53.10	37.13
Large enrolment (>400)	0.47	0.80	0.82

Table 2
Descriptive Information on Students in ISHS and Comparison Schools, Original and After Propensity Score Weighting

	ISHS (n=2076)	Within-district comparison (n=26961)			Out-of-district comparison (n=9719)		
	Original	Original		Weighted	Original		Weighted
Demographic background							
Female	0.47	0.48		0.47	0.48		0.46
African American	0.66	0.38	**	0.66	0.30	**	0.64
Hispanic	0.12	0.11		0.12	0.08	**	0.13
Economically Disadvantaged	0.63	0.44	**	0.63	0.56	**	0.63
LEP	0.07	0.07		0.07	0.05	**	0.08
Special Ed	0.14	0.14		0.14	0.14		0.14
8th-grade achievement							
Gifted in math	0.08	0.14	**	0.08	0.06	**	0.08
Gifted in reading	0.07	0.14	**	0.07	0.06		0.07
Took Algebra I	0.23	0.26	**	0.22	0.18	**	0.23
8th-grade Science	149.07	151.26	**	149.01	150.30	**	149.12
	(8.94)	(9.65)		(2.51)	(9.11)		(4.21)
8th-grade math	360.38	361.62	**	360.32	360.60		360.35
	(8.50)	(9.36)		(2.41)	(8.71)		(4.01)
8th-grade reading	357.16	358.81	**	357.10	358.11	**	357.08
	(8.52)	(9.07)		(2.38)	(8.67)		(4.00)
8th-grade anticipated math grade	2.49	2.50		2.48	2.45		2.48
	(1.09)	(1.11)		(0.29)	(1.12)		(0.50)
8th-grade anticipated reading grade	2.51	2.64	**	2.51	2.54		2.50
	(1.06)	(1.08)		(0.29)	(1.11)		(0.50)
Teacher math judgement	2.88	2.92	*	2.88	2.89		2.87
	(0.81)	(0.90)		(0.25)	(0.87)		(0.40)
Teacher reading judgement	2.80	2.92	**	2.79	2.89	**	2.78
	(0.82)	(0.89)		(0.24)	(0.84)		(0.39)
progressive science instruction	0.48	0.49		0.48	0.46	*	0.48
	(0.31)	(0.31)		(0.09)	(0.32)		(0.14)
progressive math instruction	0.50	0.52	**	0.50	0.50		0.51
	(0.32)	(0.32)		(0.09)	(0.32)		(0.15)
Time on homework	1.88	2.01	**	1.88	1.82	**	1.89
	(0.97)	(1.03)		(0.27)	(0.96)		(0.45)

Note. Standard deviations are shown in parentheses for continuous variables.

** Significantly different from ISHS students at p<.01.

* Significantly different from ISHS students at p<.05.

Table 3
ISHS Impact Estimates for Within-district Comparison

	Fixed effects estimate		Odds ratio	Fixed effects SE	Fixed effects p-value
Persisted to 12th grade	0.63	**	1.87	0.16	0.00
Earned a diploma	0.64	**	1.89	0.16	0.00
Took ACT/SAT	0.60	**	1.82	0.18	0.00
Planned to attend a 4-year college	0.43	*	1.54	0.17	0.01
Planned to attend a 2- or 4-year college	0.58	**	1.79	0.17	0.00

** p<.01, * p<.05

Table 4
ISHS Impact Estimates for Out-of-district Comparison

	Fixed effects estimate		Odds ratio	Fixed effects SE	Fixed effects p-value
Persisted to 12th grade	1.79	**	5.99	0.41	0.00
Earned a diploma	1.81	**	6.08	0.41	0.00
Took ACT/SAT	1.31	**	3.69	0.34	0.00
Planned to attend a 4-year college	0.79	**	2.20	0.31	0.01
Planned to attend a 2- or 4-year college	1.42	**	4.15	0.33	0.00

** p<.01, * p<.05