The Effect of a Collective Impact Model of Teacher Professional Development on Increasing the Number of Certified Computer Science Teachers in Rural Areas

Jayce R. Warner, Carol L. Fletcher, Ryan Torbey, & Lisa S. Garbrecht
September 2020

What We Studied

Students living in rural areas are less likely to attend schools that offer computer science (CS) courses largely because educational institutions in these remote areas lack the resources to staff teaching positions for these courses. This study investigated the impact of WeTeach_CS, a program designed to train teachers to become certified to teach high school CS in Texas. The WeTeach_CS collective impact model may be well suited to influence rural areas at scale because it utilizes an existing network of organizations across the state to bring high-quality professional development opportunities to teachers in remote areas. Results from an interrupted time series analysis showed a significant, positive change in the rate in which the number of certified CS teachers in rural areas increased during the period of time after WeTeach_CS began compared to the period before the program was implemented, whereas the number of teachers certified in technology applications showed no such change. Furthermore, the growth rate in the number of certified CS teachers was much higher for rural schools than urban, suggesting that collective impact models like WeTeach_CS may be especially beneficial for rural communities.

Schools in rural areas are behind their more urbanized counterparts in terms of access to CS education (Google Inc. & Gallup Inc, 2017). Rural schools constituted only 10% all U.S. public schools that offered an AP computer science course in 2017 (College Board, 2018), even though the latest estimates show that 28% of all public schools in the U.S. are designated as rural and 42% as rural or small-town (National Center for Education Statistics, 2014). At the core of this issue is that the lack of qualified CS teachers overall is exacerbated in rural areas, where schools have a relatively harder time funding new teaching positions and recruiting highly qualified teachers to fill those positions. Schools simply cannot offer courses for which they have no qualified teacher, implying that one crucial antecedent to increasing access to CS education for underserved students is increasing the CS teacher workforce in those areas.

Efforts to increase the number of qualified CS teachers are invariably met with challenges of scalability and sustainability. Collective impact models (Kania & Kramer, 2011), which unite interdisciplinary partners towards a common goal, may be better suited to overcome these challenges than stand-alone interventions. A collective impact model has the potential to effect change in rural schools because it connects local education agencies with resources and expertise to which they may not otherwise have access. The WeTeach_CS program has worked extensively with rural schools and teachers over the past three years to build capacity for K-12 CS Education. Approximately 40% of the 640 schools served by WeTeach_CS in 2016-17 are in rural or small-town districts. WeTeach_CS, which serves teachers across multiple districts, is particularly helpful in creating an economy of scale for CS teacher professional development that is not possible to obtain for individual small, rural districts. WeTeach_CS supports sustainability of program effects by using a network of professional development partners to support local teachers before and after becoming certified to teach CS.

How We Analyzed the Data

This research project examines the effectiveness of the WeTeach_CS collective impact model for increasing the number of certified CS teachers in rural schools. Interrupted times series (ITS) analysis was used to investigate the impact of the WeTeach_CS program on the number of certified computer science teachers in rural schools. ITS is a quasi-experimental method that tests whether the introduction of an intervention produces a change in the target outcome over time for the treatment group to a greater degree than a comparison group. We refer to the periods of time before and after the introduction of the program as the pre-intervention and intervention phases, respectively. Two types of causal effects can be estimated with ITS: level change and slope change. In the current analysis, the presence of a level change would mean a change in the number of certified teachers immediately following the introduction of the WeTeach_CS program that could not be explained by the overall trend. A statistically significant slope change would indicate that the intervention phase trend differs from the pre-intervention phase trend. Similar level and slope changes for the comparison group would suggest that the observed changes for the treatment group were due to some other factor not accounted for in the analysis.

We hypothesized that the WeTeach_CS program would positively impact the number of certified CS teachers in rural schools but that this effect would happen gradually over time. Accordingly, we expected results to reveal a statistically significant, positive change in slope but no significant level change. To help rule out the possibility of unknown confounders, we included teachers who obtained certification in technology applications to serve as the comparison group. Technology applications is the certification most similar to the computer science licensure in terms of the content knowledge covered on the certification exam and the curricular content of the courses that a teacher holding that certification would be qualified to teach. Null results for changes in the level and slope of the number of certified technology applications teachers would support inferences that any changes in the number CS-certified teachers are attributable to the WeTeach_CS program. We included data on the number of certified teacher across six years, from the beginning of the 2011-12 school year through the end of the 2016-17 school year.

What We Discovered

Results showed that, as expected, the level change was not statistically significant, indicating that there was no immediate change in the number of certified CS teachers that could not be explained by the overall trend (see Table 1). However, the slope change was statistically significant, signaling that the intervention slope differed from the pre-intervention slope. The coefficient for this estimate (B=6.46) suggests that an average of approximately six more teachers were certified each month in the intervention phase than in the pre-intervention phase. By adding the slope-change coefficient to the coefficient for the preintervention slope (B=0.33), we can calculate the actual slope for the intervention phase.

In doing so, we note that an average of about seven new teachers were certified in CS each month during the time after WeTeach_CS began compared to an average of less than one new teacher per month during the time before WeTeach_CS was implemented. Figure 1 illustrates these trends.

Table 1. Results of the interrupted time series analysis for teachers certified in computer science

	B	SE	*t*	*p*
Pre-intervention slope	0.33	0.15	2.94	.037
Level change	3.09	3.79	0.82	.418
Slope change	6.46	0.44	14.59	.000
Constant	57.47	4.91	11.48	.000

To check whether these trends were similar or dissimilar to the trends for urban-suburban school districts, we conducted the same analysis for CS teachers in those areas. The statistical significance of this analysis was similar to that of rural schools in that there was no level change but there was a significant change in slope from the pre-intervention to the intervention phase ($t(57)=9.11$, $p<.001$), indicating that there was a significant increase in the rate at which teachers in urban-suburban districts became certified after the start of WeTeach_CS compared to the period of time before the program. However, the rate at which teachers became certified in rural areas was substantially larger than urban-suburban areas. Whereas the number of certified CS teachers in urban-suburban areas increased by 88% during the intervention phase, it increased by 169% in rural areas during the same period (see Figure 2).

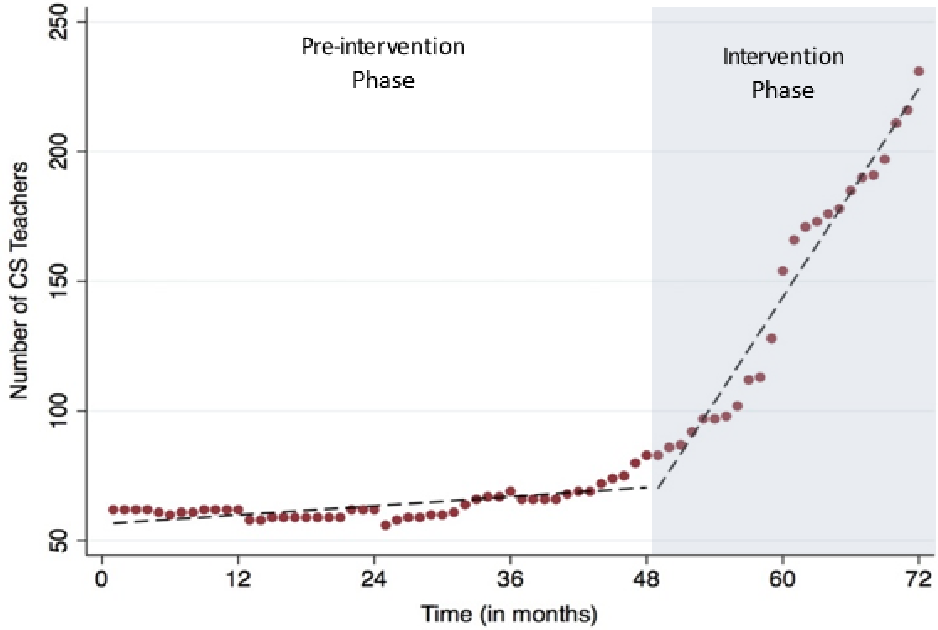

Figure 1. The number of certified CS teachers in rural areas before and after the start of the WeTeach_CS program

To ensure this difference between rural and urban-suburban areas was unique to the intervention phase and not simply a continuation of differences that existed prior to the intervention, we calculated the percent change for comparable periods of time before and after the start of the WeTeach_CS program. Because the intervention phase comprised a two-year period and the pre-intervention phase comprised a period of four years in the analysis, we calculated the pre-intervention percent change using just the two years prior to the start of WeTeach_CS and found that the number of CS teachers increased by 31% in urban-suburban areas and 34% in rural areas during this time period. Thus, whereas the rate in which teachers became certified in urban-suburban areas was twice as large during the two years of the intervention phase than the last two years of pre-intervention phase (63% vs 31%, respectively), it was over five times greater in rural areas (178% vs 34%).

To aid in ruling out the presence of unknown confounding factors, an interrupted time series analysis was run on the comparison group, rural teachers obtaining certification in technology applications. In conducting this analysis, we followed the same procedures used to conduct the analysis for rural CS teachers. Results showed no statistically significance change in level or slope (see Table 2).

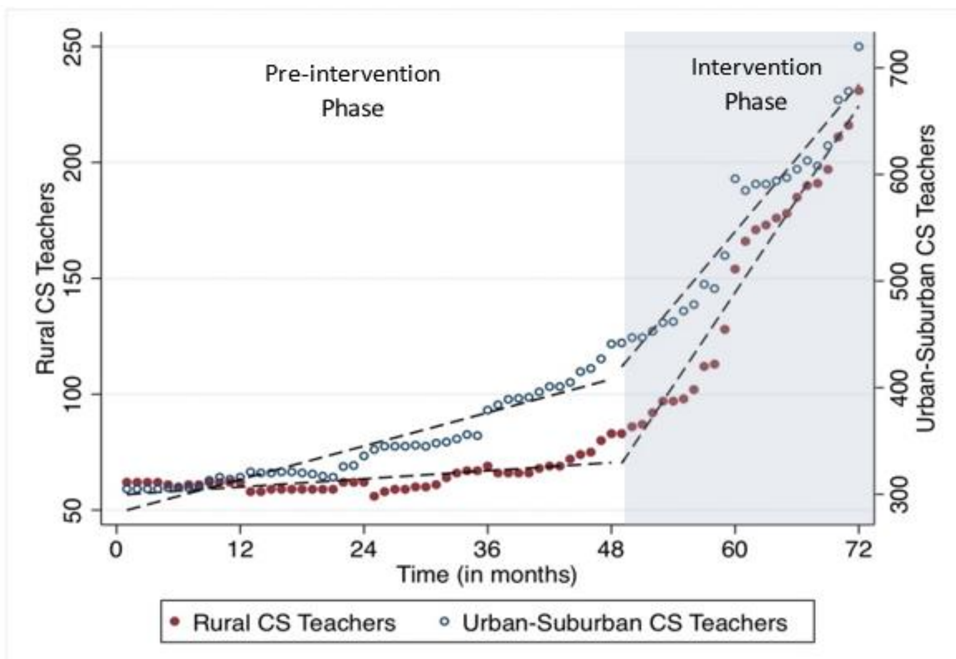

Figure 2. The number of certified CS teachers in rural and urban-suburban areas before and after the start of the WeTeach_CS program

Thus, we conclude that there were no changes in the number of certified technology applications teachers immediately after the start of the intervention phase that could not be accounted for by the overall trend, nor was there any difference between the trends in the intervention and pre-intervention phases.

Table 2. Results of the interrupted time series analysis for teachers certified in technology applications

	B	SE	t	p
Pre-intervention slope	4.33	0.63	6.83	.000
Level change	-2.24	11.55	-0.19	.847
Slope change	1.27	1.73	0.73	.467
Constant	1060.44	20.70	51.24	.000

Policy Recommendations

The results of this study demonstrate that large-scale collective impact interventions can be effective in increasing the number of certified CS teachers. Moreover, given the statistically significant change in slope between the pre-intervention and intervention phases, this study shows that program effects can be sustained over time. Perhaps most importantly, the WeTeach_CS program seemed to have had an even greater impact in rural schools, where the number of certified CS teachers increased by 178% compared to 63% in urban-suburban areas.

Whereas previous research on increasing the teacher workforce in high-need areas focused on interventions enacted on relatively smaller scales (typically at the district level), this study provides evidence for the effectiveness of a large-scale intervention as it was implemented across an entire state. WeTeach_CS appears to be implementing a promising strategy yielding positive results across the large socioeconomic and geographic diversity of Texas. We believe the distinguishing factors that have contributed to the success of the WeTeach_CS program lay in its utilization of the collective impact model as well as its combination of financial incentives with ample available training. The results of this study provide strong evidence for the value of collective impact models for effecting change in rural areas and across large geographic regions generally.

The unique impact on rural areas may have been due to three challenges that rural school districts face to a greater degree than urban and suburban districts. First, while many school districts, regardless of geography, lack computer science expertise, school districts in urban and suburban areas can often tap into nearby institutions of higher education and industry partners to access resources. Second, administrators and teachers in rural communities often have overlapping responsibilities due to the small school size and simply lack the bandwidth to launch and support new initiatives in which they lack personal expertise. Finally, it if often the case that rural school districts simply lack the ability to afford expensive initiatives, such as implementing new courses and training teachers in new content areas.

We theorize that WeTeach_CS has been more successful in rural communities because it addresses these specific challenges. Collective impact models like WeTeach_CS, which function at a large scale and create collaborative networks of like-minded organizations, can be especially beneficial for educational institutions in remote areas. With the collective impact model, small rural schools can leverage the expertise of the network to compensate for limited CS expertise within their organizations. While these schools are geographically isolated, through collective impact they become connected to institutions of higher education, industry partners, and other teachers and schools all focused on addressing the same challenges. Because rural schools have relatively few teachers, it is difficult for individual school districts to achieve an economy of scale to support the creation and growth a CS program. However, in a collective impact model the investment can be distributed across an entire statewide network, thus achieving the economy of scale that would be too inefficient for rural districts to do on their own. The CS certification preparation training provided by the WeTeach_CS program purposefully leverages the strengths of the collaborative network, allowing the local organizations to utilize their existing relationships with teachers to propagate the online course and promote in-person training sessions. This allowed the initiative to scale more quickly into all areas of the state while keeping the financial cost to schools and districts at manageable levels.

The full published version of this study can be found at https://doi.org/10.1145/3287324.3287418

References

College Board. (2018). AP computer science expansion. Report. https://reports.collegeboard.org/ap-program-results/ap-computer-science-expansion

National Center for Education Statistics. (2014). Rural education in America. Data Table. https://nces.ed.gov/surveys/ruraled/tables/a.1.a.-2.asp

Google Inc. and Gallup Inc. (2017). Computer science learning: Closing the Gap: Rural and Small Town School Districts. Report. http://goo.gl/hYxqCr

Kania, J. & Kramer, M. (2011). Collective impact. Stanford Social Innovation Review 9, 1 (2011), 36–41. https://ssir.org/articles/entry/collective_impact