Programming the Acceleration of Computing Education (PACE) Framework for CS Systems Change

EIR Grant Findings Report

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Education Development Center
300 5th Avenue, Suite 2010
Waltham, MA 02451

Submitted by:
Abt Global LLC
6130 Executive Boulevard
Rockville, MD 20852

About This Report

This report provides findings from the Abt Global independent evaluation of the *Programming the Acceleration of Computing Education (PACE) Framework for CS Systems Change* intervention. The PACE Framework was implemented in Massachusetts middle schools by the PACE team, a collaboration between Education Development Center, Inc. (EDC) and the Massachusetts Department of Elementary and Secondary Education (DESE). The evaluation was funded by EDC's Education Innovation and Research (EIR) Early-Phase Grant (Award No. U411C190275) from the U.S. Department of Education.

The views expressed in this report do not necessarily reflect the views or policies of the U.S. Department of Education.

Authors

Ellen Bobronnikov

Daniel Litwok

Kaitlyn Ciaffone

Anjali Pai

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Abt Global LLC | 6130 Executive Boulevard | Rockville, MD 20852

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[1] During the time Abt served as the external evaluator for the PACE evaluation it also held the Education Innovation and Research (EIR) Evaluation Technical Assistance support contract that provided evaluation support to the Fiscal Year 2019 cohort of EIR grantees. No one on the Abt evaluation team had a role on that contract. The Abt evaluation team received support from an EIR technical assistance liaison from Century Analytics, Inc. The Abt evaluation team did not have any information about other EIR grants or forthcoming resources and guidance not yet provided to other EIR grantees or their evaluators.

Executive Summary

Education Development Center (EDC) was awarded an Education Innovation and Research (EIR) Early-Phase Grant in 2019 to implement, refine, and evaluate the **Programming the Acceleration of Computing Education (PACE) Framework for Computer Science (CS) Systems Change**. This report presents findings from the EIR-funded independent evaluation of the PACE intervention conducted by Abt Global (Abt). SageFox Consulting Group led the initial design planning for the evaluation, and Abt took over as the independent evaluator after the first year.

PACE Overview

The PACE framework is a comprehensive district change model designed to support access to CS education for all middle school students. To achieve systemic change at the district level, the PACE intervention includes state- and district-level leadership commitments and consists of three key components: (1) district-level commitment to systemic CS instruction with teaching practices focused on providing access to all students, including the formation of and participation in district stakeholder councils (DSCs); (2) teacher training in the *Computer Science Discoveries*® (*CS Discoveries*) curriculum developed by Code.org; and (3) districtwide requirement for all middle school students to enroll in a high quality CS curriculum that meets the Massachusetts Department of Elementary and Secondary Education's (DESE's) Digital Literacy and Computer Science (DLCS) standards, which could be taught over a two- or three-year period.

The PACE logic model hypothesizes that the three key components of the PACE intervention will increase student understanding of CS principles, interest in CS, and participation in CS education for all students in the short term. In the medium and long term, PACE is hypothesized to increase student achievement and enrollment in high school CS courses and promote entry of more students into CS careers. These changes are expected to operate through district- and teacher-level mediators.

Evaluation Design

Six districts in Massachusetts implemented the PACE intervention. The proposal for PACE included a focus on recruitment of rural districts—four of the six were rural. This was significantly fewer districts than anticipated, but at a time when schools were facing significant COVID-19 pandemic-related disruptions, many districts were hesitant to implement a new curriculum.

Abt designed and conducted an independent evaluation of the implementation of PACE, which consisted of (1) a study of the fidelity of implementation of the PACE key components in the six participating districts ("treatment" districts), (2) a study examining the district-level mediating factors that are ultimately expected to affect student outcomes, and (3) a study of the impact of PACE on student achievement outcomes in these districts versus a set of matched districts with similar baseline characteristics ("comparison" districts).

- The **study of the fidelity of implementation** of the PACE key components within the six treatment districts assessed whether the three key components were implemented as designed during the study period. Abt and the PACE team developed a fidelity measure that set thresholds for adequate implementation of each of the key components based on the percentage of districts and teachers implementing each component as designed. Abt assessed fidelity of implementation

using data collected by the PACE team from treatment districts as well as data collected by Code.org on teacher participation in *CS Discoveries* training and professional development.

- The **study of district-level mediating factors** examined whether treatment and comparison districts experienced changes during the study period in factors that are expected to be affected by the PACE intervention. The factors explored included the establishment of a CS course sequence in middle school and developing infrastructure for sustaining high school CS pathways. This study relied on two primary data sources:
    - To examine student enrollment in CS, the study used DESE's Student Course Schedule database, which includes information on all courses taken by students in Massachusetts public school districts.
    - To measure other district-level mediators, the study used a District Infrastructure Survey developed and administered annually to treatment and comparison districts. Analyses focus specifically on responses to data elements related to:
        - Establishment of a CS course sequence in middle school that has potential to lead into a high school CS pathway.
        - District leadership capacity to oversee high school CS pathways for students.
        - Structures and processes in place that support sustained CS prioritization.
        - Community resources in place that support CS education.
- The **study of the impacts on student achievement** used a district-level quasi-experimental design to compare average achievement on the grade 8 Massachusetts Comprehensive Assessment System (MCAS) between the treatment and comparison districts. Abt designed the impact study to meet What Works Clearinghouse (WWC) Group Design Standards (Version 5.0) under the assumption the study would be reviewed under the WWC Study Review Protocol (Version 5.1; What Works Clearinghouse (2024)). Because comparison students do not necessarily enroll in CS courses, the study examined outcomes in the mathematics and science achievement domains, which were only weakly aligned with the intervention.[2] The evaluation team prespecified two confirmatory outcomes that were measured using total points awarded for two MCAS "reporting subcategories" within the grade 8 content areas identified to be the most closely aligned to the skills taught in the *CS Discoveries* curriculum: geometry and life sciences.[3] These outcomes were selected because they were deemed to be most closely aligned to the intervention among the MCAS reporting subcategories—geometry because the programming through the *CS Discoveries* course requires students to work with Cartesian graphs, coordinates, and angles, and life sciences because it assesses students' ability to read tables, interpret data, and apply logic to reach conclusions. These outcomes had the benefit of being collected for both the treatment and comparison groups and coming from state assessments that have acceptable reliability metrics.

[2] A more direct measure of CS interest or aptitude would be considered overly aligned with the intervention. As a result, these measures were ruled out for the impact study.

[3] MCAS reporting subcategories measure knowledge and skills associated with a specific content area (https://www.doe.mass.edu/mcas/tech/2023-nextgen-tech-report.pdf).

Findings

Fidelity of Implementation of PACE Key Components

- Although the PACE key components were slightly modified to account for pandemic-related challenges, four out of six treatment districts were able to meet the adjusted fidelity thresholds for all three key components.

District-Level Mediating Factors

- All treatment districts established a CS course sequence in middle school; only one comparison district had high levels of CS enrollment in more than one middle school grade.
- Half of the treatment districts already had high levels of middle school CS enrollment for some portion of their middle school grades prior to implementing the PACE intervention.
- Most treatment districts had greater infrastructure to sustain high school CS pathways than did their matched comparison districts.

Impacts on Student Achievement

- PACE did not affect grade 8 MCAS geometry or life sciences reporting subcategories.
- PACE also did not affect any of the other math and science reporting subcategories[4] or overall grade 8 MCAS math and science scores.
- The lack of impacts on student achievement may be explained by the small number of districts included in the study and the lack of alignment between the intervention and the outcomes examined.

Discussion

Lessons learned during the course of the evaluation provide evidence upon which future PACE-like interventions could plan their design and implementation:

- Target recruitment to districts with existing CS infrastructure.
- Be prepared to adapt.
- Build flexibility into professional learning communities.
- Support sustainability of district stakeholder councils.

The evaluation also encountered evaluation-related challenges that are useful to document for future evaluations of CS interventions:

- Anticipate recruitment challenges for district-level interventions.
- Measure and document treatment and comparison experiences to explain impacts (or lack thereof).

[4] Other reporting subcategories assessed included number system and expressions/equations; functions; statistics and probability; Earth/space sciences; physical sciences; and technology and engineering.

- Anticipate that identifying CS outcome measures that meet WWC standards can be challenging.

Additional refinement of the intervention model to facilitate recruitment and implementation coupled with evaluation of a more closely aligned outcome measure will be important steps for future evaluations of PACE-like interventions to maximize their likelihood of demonstrating impact on student-level outcomes.