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Professional Learning Communities and Student Outcomes:

A Quantitative Analysis of the PLC at Work Model in Arkansas Schools

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Abstract:

This study evaluates the impact of the Professional Learning Communities (PLC) at Work model on student achievement and growth in Arkansas schools. Implemented through a partnership between the Arkansas Department of Education and Solution Tree, the program promotes collaborative professional development among educators. Using a matching process and an event study framework, we analyze longitudinal data on student performance in English Language Arts (ELA) and mathematics from multiple cohorts of schools.

The overall results reveal mixed outcomes. While no statistically significant improvements were observed in overall student achievement or growth, there were concerning trends for economically disadvantaged students. This subgroup exhibited consistent negative associations with program participation, particularly in mathematics, suggesting the PLC at Work model may not be positively impacting these students. Additionally, while some cohorts showed temporary positive effects in ELA growth, these did not persist. The results raise concerns about the program's current effectiveness and suggest a need for enhanced oversight and accountability. The study contributes valuable insights for policymakers and educators aiming to leverage professional development initiatives to enhance student outcomes.

Keywords: Professional learning communities, PLCs, PLC at Work, professional development

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I. Introduction

Professional Learning Communities (PLCs) have gained significant traction as a model for professional development within the educational landscape (Stoll et al., 2006). While there is no single, universally accepted definition of a PLC, they are typically characterized by a framework of collaborative learning among teachers (Stoll et al., 2006; Ward, 2023). Schools utilizing PLCs organize teachers into working groups to foster practice-based professional learning with aims of achieving improved student learning outcomes. PLCs diverge from traditional, stand-alone professional development (PD) programs by fostering a more comprehensive, school or district-wide effort prioritizing continuous improvement (DuFour & Eaker, 1998; Stoll et al., 2006; Ward, 2023). The emphasis extends beyond individual educator development to encompass the overall school culture and structure.

In 2017, the Arkansas State Legislature passed Act 427 which allocated additional funding for the development and administration of PLCs to benefit public school districts (Arkansas Code Annotated, § 6-20-2305(b)(5)). Subsequently, a partnership began between Arkansas schools and Solution Tree, a consulting and professional development company specializing in PLC implementation. Through this partnership, Solution Tree's PLC at Work program was implemented statewide. Public schools across Arkansas are eligible to apply to become a PLC at Work school. Selected schools receive intensive on-site professional development services to support the full implementation of PLCs, including, but not limited to, up to 50 days of on-site training, coaching, and support from certified Solution Tree PLC at Work associates, access to a comprehensive resource library, and invitations to attended Solution Tree conferences and events.

This research paper addresses the question: **How does Solution Tree's PLC at Work model impact student achievement and growth in Arkansas schools?** Leveraging publicly available data from the Arkansas Department of Education, we employ a rigorous quantitative analysis to examine the PLC at Work program's effectiveness across multiple cohorts of schools. Our methodology incorporates a two-stage matching process and a difference-in-differences framework to isolate the effects of the PLC at Work initiative on student performance.

This study provides the first large-scale evaluation of the PLC at Work model's effectiveness, offering valuable insights into its potential to improve educational outcomes in diverse school settings. The significance of this research lies in its contribution to the empirical evidence on PLCs. By examining a statewide implementation, this study offers insights into the scalability and effectiveness of the PLC at Work model in improving student performance. The findings hold significant implications for policymakers, educators, and researchers interested in leveraging professional development to enhance educational practices and student outcomes.

II. Study Context

Professional Learning Communities and Solution Tree

Professional Learning Communities (PLCs) are a framework for educational professional development focusing on collaboration and continuous learning among educators. PLCs aim to improve student outcomes by fostering an environment where educators work together to explore best practices, implement instructional strategies, and assess their effectiveness through ongoing, job-embedded learning. The framework, as Richard DuFour and Robert Eaker articulated, includes several key characteristics: a shared mission, vision, values, and goals; collaborative teams focused on learning; a collective inquiry into best practices; action orientation and experimentation; commitment to continuous improvement; and a results-oriented approach (DuFour & Eaker, 1998).

Solution Tree is a company that supports the implementation of PLCs by providing professional development services and resources. Their PLC at Work process includes up to 50 days of on-site professional development annually, covering training, coaching, and observations. Training sessions address topics such as leadership coaching, assessment, and interventions. Additionally, schools receive extensive print and video resources to support implementation and are encouraged to participate in conferences to share best practices and strategies (*PLC at Work in Arkansas*).

Arkansas Context

The implementation of the PLC model in Arkansas is supported by Act 427 of 2017, which mandated increases in professional development funding to be used each school year to develop and administer professional learning communities (Arkansas Code Annotated, § 6-20-2305(b)(5)). In 2017, the Arkansas Division of Elementary and Secondary Education (DESE) launched the PLC at Work program in partnership with Solution Tree (*Press Release: Arkansas Launches Professional Learning Communities Pilot Project*, 2017). This initiative responded to the 2016 Adequacy Report recommendations and aimed to enhance learning outcomes for students and educators by promoting the PLC at Work process in selected Arkansas schools. DESE defines a PLC as an "ongoing process in which educators work collaboratively in recurring cycles of collective inquiry and action research to achieve better results for the students they serve" (Bureau of Legislative Research, 2016). The underlying assumption is that continuous job-embedded learning for educators is the key to improving student learning.

The Arkansas PLC at Work initiative includes 90 schools selected through a rigorous application and evaluation process (*PLC at Work in Arkansas*). At the program's start, a needs assessment examines process and achievement data, while formative assessments throughout the year evaluate growth and determine the next steps. Each participating school receives a customized plan based on the needs assessment and is paired with a certified Solution Tree PLC at Work Associate or Site Coach to coordinate implementation. This coach is overseen by a project management team that monitors, assesses, and reports on school services, providing feedback to DESE. Schools receive a comprehensive resource package to ensure successful program implementation and sustainability. Resources include up to 50 days of on-site professional development delivered by certified associates, access to a library of digital and print resources (books, videos, online courses, Global PD subscription), and participation in PLC events and conferences. Solution Tree's library of PLC-related content (case studies, best practices, research findings) further supports educators' continuous learning and collaboration. Throughout the process, ongoing support is provided through regular communication with Site Coaches, ensuring timely assistance for educators. Participation in the PLC at Work program aims to increase student achievement and growth through teacher collaboration, a focus on learning, and a results orientation. PLC members utilize data collected and analyzed at the school level to drive their decision-making process.

Financial Relationship

The financial relationship between Arkansas and Solution Tree has evolved significantly since 2017 when the state awarded Solution Tree a one-year $4 million no-bid contract (Roberts, 2024). This contract has grown over the years to a $16.5 million per-year contract. According to Arkansas State Representative Grant Hodges, the total financial benefit to Solution Tree, considering contracts from the state Department of Education, education service cooperatives, school districts, and higher education institutions, exceeds $140 million (Roberts, 2024). This substantial investment has raised questions about the effectiveness of PLC at Work providing benefits to Arkansas teachers and students.

III. Review of Literature

The materials for Solution Tree's Professional Learning Communities (PLC) program state that implementing it will "increase student achievement and ensure learning for all," however, there is limited peer-reviewed quantitative research examining the relationship between the implementation of PLCs and increased student performance on standardized assessments. As noted by Bolam et al. (2005), however, "There is no universal definition of a PLC" (p.5). In a 2008 review of the literature on professional learning communities, only one peer-reviewed quantitative study that examined the relationship between teachers' participation in learning communities and student achievement was identified. (Vescio el al., 2008). Although not specifically Solution Tree's PLC model, the study of 24 schools found that higher achievement levels were related to strong professional communities in schools (Louis & Marks, 1998).

Several studies have been conducted since Vescio's review that examine the relationship between teacher collaboration teams and student achievement. A study of 47 elementary schools in a large midwestern school district found that fourth-grade students have higher achievement in mathematics and reading when they attend schools characterized by higher levels of teacher collaboration (Goddard et al., 2007). In a quasi-experimental study, Saunders et al. (2009) found that nine elementary schools that implemented a process for focusing grade and school-level instructional teams on improving student learning produced significantly greater achievement gains than those in six comparison schools. A study on a school in Iceland found possible positive associations between introducing professional learning communities and student academic outcomes (Sigurðardóttir, 2010). A methodologically rigorous study examining whether teacher collaborations in 336 Miami-Dade Country, Florida public schools predicted school-level value-added growth in student achievement found that teachers and schools that engage in better quality collaboration have small statistically significant impacts on value-added scores in math and reading (Ronfeldt et al., 2015). Burns et al., 2018 found small to moderate correlations between the levels of collaborative leadership process and data-driven systems for learning and student achievement in 181 Missouri schools that implemented PLCs. (Burns et al., 2018). When examined by content area, mathematics achievement was generally more positively impacted than literacy achievement, consistent with prior research (Ronfeldt et al., 2015; Sigurðardóttir, 2010).

While the studies discussed previously considered teacher collaboration teams broadly, some studies have focused on Solution Tree's model of PLCs specifically. A 2015 study of five elementary schools revealed small but statistically significant correlations between student achievement on the state assessment for three PLC dimensions: collaboratively reviewing student work, working with colleagues to judge the quality of student work, and discussing substantive student-centered educational issues (Ratts et al., 2015). One quasi-experimental study of three high schools found evidence that PLCs positively impact student achievement gains when implemented well and alongside project-based learning (Capraro et al., 2016).

While previous studies have examined student achievement related to teacher collaboration generally or the quality of PLCs specifically, this study examines the effect of implementing the PLC at Work model on student achievement and growth in Arkansas. An evaluation from Hanson et al. (2021), conducted on behalf of Solution Tree and DESE, found that after two years of PLC at Work implementation, the model had no effects on English language arts achievement test scores and positive impacts on math achievement test scores (0.083 standard deviations, $p = 0.014$). The following groups performed statistically significantly better in math: White, Male, Non-English Language Learners, Non-Special Education Students, both economically disadvantaged and non-economically disadvantaged students, and students scoring in the top 25% on state assessments in math and English Language Arts prior to PLC at Work implementation. In English Language Arts, only students who were never economically disadvantaged showed statistically significant improvement (Hanson et al., 2021).

The authors of the 2021 evaluation suggested that future research evaluate the effects of the full three-year intervention and replicate the studies for other cohorts of schools in the Arkansas initiative. This study builds on the initial findings of Hanson et al., expanding to cover all six cohorts of Arkansas's PLC at Work schools.

IV. Methodology

Data

In this study, we leverage publicly available school data from the Arkansas Department of Education (ADE) Data Center, including student achievement scores and growth measures, to investigate the association between student achievement and growth in schools partnered with Solution Tree as PLC at Work schools.

The ADE Data Center is a comprehensive repository of data systems, tools, and reports accessible to educational stakeholders. In adherence to state and federal legislative requirements, the ADE collaborates with Arkansas public schools in data collection for public dissemination. Schools and districts contribute data through secure platforms like eSchoolPlus and eFinancePlus. The ADE validates data quality and accuracy through established procedures and reports undergo review to ensure veracity before submission. Finally, districts must sign and return a "Certification of Data Accuracy" form for each data collection cycle, as mandated by the ADE.

Student achievement data for this analysis originates from Arkansas's publicly available school report cards. Act 6-15-1402 of the Arkansas Code mandates the ADE's Division of Elementary and Secondary Education (DESE) annually produce and publish a school performance report for each public school within the state. These reports are readily accessible to schools, parents, and the local community. Furthermore, in alignment with stakeholder input, the ADE has synchronized the state's accountability system, encompassing the School Rating System, with the Arkansas Every Student Succeeds Act (ESSA) plan, which reflects federal accountability measures. The ESSA School Index score and the stakeholder-recommended rating scale serve as the basis for assigning letter grades (ratings) to schools.

Our analysis utilized a comprehensive longitudinal dataset for each school year from 2016-17 to 2022-23 obtained from the ADE Data Center. This data encompassed student performance metrics English Language Arts (ELA) and mathematics from required state assessments for students in grades 3-10. Weighted achievement scores for all students and economically disadvantaged students, was included along with the corresponding student counts used for calculating the weighted achievement. Additionally, value-added growth scores were obtained, for both the overall student population and economically disadvantaged students. The number of students contributing to each growth score calculation was also included in the data.

To facilitate appropriate group comparisons, supplementary school-level data was collected. This data comprised school characteristics such as grade span, total enrollment, and the percentage of students meeting benchmark readiness standards in ELA and math. Student demographic data was obtained, including the percentage of students categorized as male, Black, Hispanic/Latino, or white. The data also included the percentage of students eligible for various federal programs such as English language learners (ELL), free or reduced-price lunch (FRL), and special education services (SPED). Finally, data on teacher experience was collected, including average years of experience and the percentage of teachers with less than three years of experience.

Sample

PLC at Work schools received specialized support and resources to implement the PLC at Work model. DESE selected these schools through a competitive application and evaluation process (*PLC at Work in Arkansas*). A panel of education professionals with expertise in the PLC at Work model reviewed applications and employed a scoring rubric to select schools for participation. Table 1 presents the characteristics of selected schools in the year preceding their partnership with Solution Tree with the characteristics of all other Arkansas schools.

Table 1
Student Enrollment, Teacher Characteristics, and Baseline Achievement in PLC at Work Schools vs. Other Arkansas Schools, 2016-2023

	Project Schools N=90	**All Other AR Schools** N=975
Average Student Enrollment Characteristics		
Enrollment	488	451
% African American/Black	23	20
% Hispanic/Latino	15	11***
% White	56	63**
% Free or Reduced-Price Lunch	77	68***
% English Language Learners	10	7***
% Special Education	14	14
Average Teacher Characteristics		
Years of Teaching Experience	10.48	10.55
% Inexperienced Teachers	20	20
Percentage of Students who Met/Exceeded Benchmark Standards on State Assessments		
English Language Arts	37	42***
Math	37	42***

**** p<0.01, **p<0.05, *p<0.1*

Note: Due to the selection focus on traditional public schools, data presented in 'All Other AR Schools' column excludes charter schools/charter school networks, private schools, primary schools, and schools providing special services.

As shown in Table 1, in the year prior to selection to participate in the PLC at Work program, PLC at Work schools enrolled a statistically significantly greater percentage of students who are Hispanic/Latino, are eligible for Free or Reduced-Price Lunch, and are English language learners than schools not selected to be PLC at Work schools. Additionally, in the year before selecting for participation in the PLC at Work program, students in selected schools were statistically significantly less likely to meet or exceed standards on state assessments in ELA and mathematics than students in schools not selected to be PLC at Work schools[1].

Analytic Approach

Following the prior evaluations of PLC at Work schools conducted by Education Northwest, our study employed a two-stage analytical approach to investigate the association between in PLC at Work participation and student achievement and growth (Hanson et al., 2021). The first stage focused on establishing baseline equivalency between treatment and comparison groups through a matching process, detailed below. Following this matching procedure, we implemented an event study analysis to estimate the impact of PLC at Work participation on student academic performance. This event study analysis was conducted for both the overall student population and a subgroup of students qualifying for free or reduced-price lunch, a common proxy for low socioeconomic status.

PLC at Work Cohorts

To explore the connections between PLC at Work schools and student academic outcomes, we employed a cohorting strategy. Schools designated as PLC at Work partners with Solution Tree were assigned cohorts based on their initial partnership year. This cohort structure addresses the potential influence of varying implementation timelines across selected schools. This cohort structure addresses a potential confounding effect, or when a third variable, not directly related to PLC at Work implementation, influences our outcomes of interest. Table 2

[1] Two PLC at Work schools, Booker Arts Magnet School in the Little Rock School District and Pinewood Elementary School in the Jacksonville North Pulaski Special School District were excluded from the final sample due to their closure after program participation. Pinewood Elementary merged with Warren Dupree Elementary to form Jacksonville Elementary School, a PLC at Work school within Cohort 3. To reasonably estimate Jacksonville Elementary's pre-implementation data, we used the combined weighted averages of the prior year's scores from both Pinewood Elementary and Warren Dupree Elementary.

presents information about cohorts and the year they were selected to be PLC at Work schools. Note that because standardized testing was cancelled in 2019-20 due to due to COVID-19 school closures, Cohort 3 includes schools that started as PLC at Work schools in both 2019-20 and 2020-21. A full description schools and districts across cohorts, along with the year they joined the PLC at Work program, can be found in the appendix.

Table 2
Cohorting and Adoption Years of PLC at Work Schools by Grade Span

Cohort	PLC at Work Adoption Year	N	Grade Span: Elementary	Grade Span: Middle	Grade Span: High
Cohort 1	2017-18	11	6	2	3
Cohort 2	2018-19	13	8	2	3
Cohort 3	2019-20 & 2020-21	25	13	2	10
Cohort 4	2021-22	18	11	4	3
Cohort 5	2022-23	23	8	6	9

Matching Approach

To achieve baseline equivalency between PLC at Work schools and comparison groups, we employed a one-stage propensity score matching (PSM) technique (Rosenbaum & Rubin, 1983). In Arkansas, schools applied to participate in the PLC at Work program, introducing the potential for selection bias. Selection bias could occur if there was non-random assignment of schools selected as PLC at Work school and comparison schools, distorting the observed relationship between the PLC at Work schools and students' academic outcomes. PSM addresses this by creating a group of comparison schools that statistically resemble the treatment group on a set of relevant characteristics, or covariates, that might influence student outcomes.

Several considerations informed the selection of schools for comparison. District-run charters were excluded from the matching process due to the focus on traditional public schools as program schools. Schools catering to specific student populations, such as the Arkansas

School for the Blind and Visually Impaired or those within the Arkansas Correctional School District, were also excluded. Furthermore, our analysis relies on annual data from state-produced school report cards, which excluded schools lacking letter grades, encompassing alternative learning environments and early childhood or pre-kindergarten schools.

In our one-stage propensity score matching (PSM) approach, we first calculated a propensity score, $p(x_j)$, for each school j. This score represents the predicted likelihood of a school being chosen for the PLC at Work program based on baseline characteristics ($\boldsymbol{X_j}$) measured in the year before their partnership with Solution Tree. These characteristics encompass various aspects of the school environment, including enrollment size (total number of students), student achievement on state-administered standardized assessments in both math and ELA categorized into achievement levels (In Need of Support, Close, Ready, or Exceeding), student demographics (percentage of male students and racial/ethnic composition of Black, Hispanic/Latino, and White students), and programmatic factors (percentage of students qualifying for free or reduced-price lunch, receiving special education services, or being English language learners). We also considered teacher experience, measured by average years of experience, the percentage of inexperienced teachers (with less than three years of experience), and the school grade span (elementary, middle, or high school). By incorporating these diverse covariates into the PSM analysis, we create a group of comparison schools that statistically mirror PLC at Work schools, mitigating the impact of potential selection bias that might arise due to the non-random selection of program schools.

$$p(x_j) = \Pr(PLCatWork_j = 1 \mid \mathbf{X}_j) \qquad (1)$$

Following the PSM process, the analysis focused exclusively on comparison schools that had a similar likelihood of participating in the PLC at Work program based on various factors.

This entails ensuring that the propensity scores of comparison schools within the matched sample lie within the range of scores observed in PLC at Work schools. The PSM analysis was completed for each cohort of PLC at Work schools. Table 3 presents the propensity score range and the resulting number of comparison schools after adjusting for common support for each PLC at Work cohort.

Table 3
Propensity Score Ranges and Number of Comparison Schools by PLC at Work Cohort

Cohort	Propensity Score Ranges Min	Max	N PLC Schools	N Comparison Schools
Cohort 1	0.0031	0.1029	11	435
Cohort 2	0.0044	0.2316	13	432
Cohort 3	0.0097	0.1163	25	667
Cohort 4	0.0060	0.2993	18	500
Cohort 5	0.0081	0.2032	23	569

Estimation Model

To assess the relationship between the PLC at Work program and student academic achievement and growth, we utilized a two-pronged approach that acknowledges the non-random assignment of schools to the program. First, a difference-in-differences (DiD) frame was utilized to estimate the program's overall effect (Callaway & Sant'Anna, 2021). This quasi-experimental design capitalizes on the staggered implementation of PLC at Work across different school cohorts, mitigating the influence of confounding variables that might affect student outcomes over time. The DiD model allows us to compare the change in student outcomes for schools designated as PLC at Work (treatment) with the change in outcomes for comparison schools during the same period. The DiD model is formulated as follows:

$$Y_{it} = \beta_1 PLCatWork_i + \gamma Post_t + \delta(PLCatWork_i \times Post_t) + \varepsilon \quad (2)$$

In equation 2, Y_{it} represents the outcome variable for student *i* at time *t*. PLCatWork_i is a binary indicator variable that takes a value of 1 if the school is identified as a PLC at Work school and 0 if otherwise. Post_t is a binary indicator variable denoting the post-intervention period. The variable takes a value of 1 for the year that a school implemented its partnership with Solution Tree for PLC at Work and for all subsequent years. The coefficient of interest, δ, captures the difference-in-differences estimator, representing the average treatment effect (ATT) of a school's participation in PLC at Work on student outcomes. ϵ represents the error term.

Secondly, we employed an Event Study methodology to have a more comprehensive exploration of the impact of PLC at Work over time. This approach allows us to examine how the program's effect unfolds across the years following implementation. The event study model is formulated as follows:

$$Y_{it} = \alpha + \sum_{r= K}^{K} \beta_r PLCatWorkStart_{itr} + \epsilon_{it} \quad (3)$$

In equation 3, Y_{it} again represents the outcome variable for student *i* at time *t*. *PLCatWorkStart* is an indicator variable capturing the presence of the intervention at time *t* relative to event year *r*. For instance, *r* could represent -1 year before implementation or +2 years after implementation. *K* represents the maximum number of years before and after the start of PLC at Work that are included in the analysis. *K* defines the time window around the event. The β_r coefficients represent the regression coefficients, capturing the outcome difference between PLC at Work and comparison schools in event year *r*. ϵ_{it} represents the error term.

Our study design possesses limitations inherent to observational research. Selection bias is a potential concern, as schools were not randomly assigned to participate in the PLC at Work program. While we employed rigorous statistical techniques to mitigate this bias, caution is necessary since the findings should not be interpreted as causal. Additionally, our analysis did not incorporate control variables for student or school characteristics. This deliberate choice aimed to maintain a parsimonious model focusing on the core association between a school's participation in PLC at Work and student outcomes. However, it is important to acknowledge the significant variation in school composition across Arkansas, encompassing factors like demographics, socioeconomic status, and prior achievement. Consequently, our results should be interpreted as the relationship between being selected to participate in the PLC at Work program on student academic outcomes. Generalizability to other contexts may be limited.

Outcomes of Interest

Our analysis targeted a set of student achievement outcomes aligned with the core objectives articulated by the program developers. Solution Tree's promotional materials emphasize the link between improved teacher collaboration and enhanced student learning. Their website states: "There's nothing more important to us than helping you increase student achievement." Since the PLC at Work program is implemented at the school level, we adopted the following student outcomes at the school level as the primary outcomes of interest.

Since PLC at Work implementation begins in the fall semester, and the state-required assessments occur in the spring semester, assessment scores for a school's first year as a PLC at Work program participant reflect post-implementation outcomes. PLC at Work schools received at least seven months of the program’s professional development before students completed the assessments.

Achievement. Our first outcome of interest is a school's average weighted achievement. This metric, generated by the ADE, reflects a school's students overall academic performance in math and ELA based on annual state-required assessments for students in grades 3-10. Unlike a simple average score, weighted average achievement incentivizes schools to improve student performance across all achievement levels. The ADE assigns points to students based on their performance categories in state assessments: 0 points for In Need of Support, 0.5 points for Close, 1 point for Ready, and 1 point for Exceeding. Additionally, schools receive a 0.5 bonus point for each student scoring Exceeding over the number In Need of Support. Total points earned by each school are divided by the number of students assessed, resulting in a possible weighted achievement score of 0 if all students scored well below grade level expectations and 150 if all students exceeded grade level performance expectations. In the 2022-23 school year, weighted achievement scores for all Arkansas schools ranged from 0 to 113, with a mean of 51.8 and a standard deviation of 16.7.

Value-Added Growth. Our analysis incorporated value-added student growth as a key outcome measure. This metric, calculated by the ADE, reflects a student's progress in math and ELA over time as assessed by annual state-required assessments in grades 3-10. This value-added model uses up to four years of prior academic achievement scores in the content area to compare a student's actual progress between prior standardized assessments to typical student progress. Annually, a value-added growth score of 80 represents that a student demonstrated academic progress typical for students across the state with similar test score histories. Scores below 80 indicate lower-than-average levels of academic progress, while scores above 80 indicate higher than average among students across the state with similar test score histories. In the 2022-23 school year, school value-added scores for all Arkansas schools ranged from 63 to 92, with a mean of 80.1 and a standard deviation of 2.8.

V. Results

The following sections present the results of our analysis, categorized by the outcome variable of interest. The figures and tables display single coefficients, representing the average difference between PLC at Work schools and the comparison schools for each outcome.

To assess the impact of PLC at Work participation, we compared the outcome measure average for PLC at Work schools in the year before program initiation with their average outcome in subsequent years. We then performed the same evaluation for the matched comparison schools within each cohort. The difference in the average outcome change between treatment and comparison schools signifies the estimated program effect on the outcome variable. This event study estimate captures the influence of PLC at Work participation on student achievement or growth measures. The resulting coefficients would be zero if schools experienced no impact from participation in the PLC at Work program. Similarly, positive coefficients indicate positive impacts, while negative coefficients suggest negative ones.

Overall Results

The findings from the difference-in-differences (DiD) analysis are presented in Table 4 below. This table summarizes the pooled estimates for the overall program effects of PLC at Work on student outcomes, examining both the entire student population and economically disadvantaged students. For the DiD analysis, the reference of pre-treatment is the average of the outcome of interest for all years prior to PLC at Work adoption.

Table 4
Average Treatment Effect Results from Difference-In-Difference Analysis, All Cohorts

	All Students	**Economically Disadvantaged Students**
Average Weighted Achievement	-0.721 (0.834)	-1.026 (0.743)
Overall Growth	-0.152 (0.310)	-0.201 (0.364)
ELA Growth	-0.023 (0.327)	-0.068 (0.405)
Math Growth	-0.287 (0.355)	-0.310 (0.377)

Standard errors in parentheses
**** p<0.01, **p<0.05, *p<0.1*

The difference-in-differences analysis did not yield statistically significant evidence indicating effectiveness of the PLC at Work program for any of the outcomes examined across for students overall or for students facing economically disadvantages. In fact, the estimates suggest a negative association between PLC at Work participation and student academic outcomes. Specifically, students enrolled in PLC at Work schools exhibited a 0.721-point decrease in average weighted achievement compared to their counterparts in non-PLC at Work schools. This negative association was even more pronounced for economically disadvantaged students, with a decrease of 1.026 points.

Similarly, analyses of school-level value-added growth revealed negative associations for PLC at Work schools. Students in these schools experienced a 0.152- and 0.201-point decrease in overall value-added growth compared to students attending non-PLC at Work schools, for all students and economically disadvantaged students, respectively. Notably, the declines in growth scores were more substantial in mathematics compared to ELA.

To more rigorously examine the association between PLC at Work participation and our outcome variables, schools were assigned to cohorts based on their initial program year, as detailed in Table 5. In the following sections, 'Year 1' through 'Year 5' signify respective years with available data for analysis. For the event study analysis, the reference of pre-treatment is the average of the outcome of the year prior to PLC at Work adoption.

Table 5
PLC at Work Start Year and Outcome Year, by Cohort

	N	PLC at Work Start	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23
Cohort 1	11	2017-18	Year 1	Year 2	—	Year 3	Year 4	Year 5
Cohort 2	13	2018-19		Year 1	—	Year 2	Year 3	Year 4
Cohort 3	25	2019-20/ 2020-21			—	Year 1	Year 2	Year 3
Cohort 4	18	2021-22			—		Year 1	Year 2
Cohort 5	23	2022-23			—			Year 1

Weighted Achievement

Figures 1 and 2 present the overall findings for average weighted achievement across all cohorts, for the general student population and economically disadvantaged students, respectively. The figure presents data on a year-by-year basis. A value of zero on the y-axis indicates that students in PLC at Work schools performed similarly to comparison schools relative to their baseline achievement. Positive values suggest that PLC at Work schools outperformed comparison schools regarding achievement gains, while negative values indicate that PLC at Work schools experienced smaller achievement gains than non-PLC at Work schools. Results are statistically significant only if the shaded area does not include zero.

Figure 1

Combined Effects of PLC at Work on Average Weighted Achievement by Year, All Students

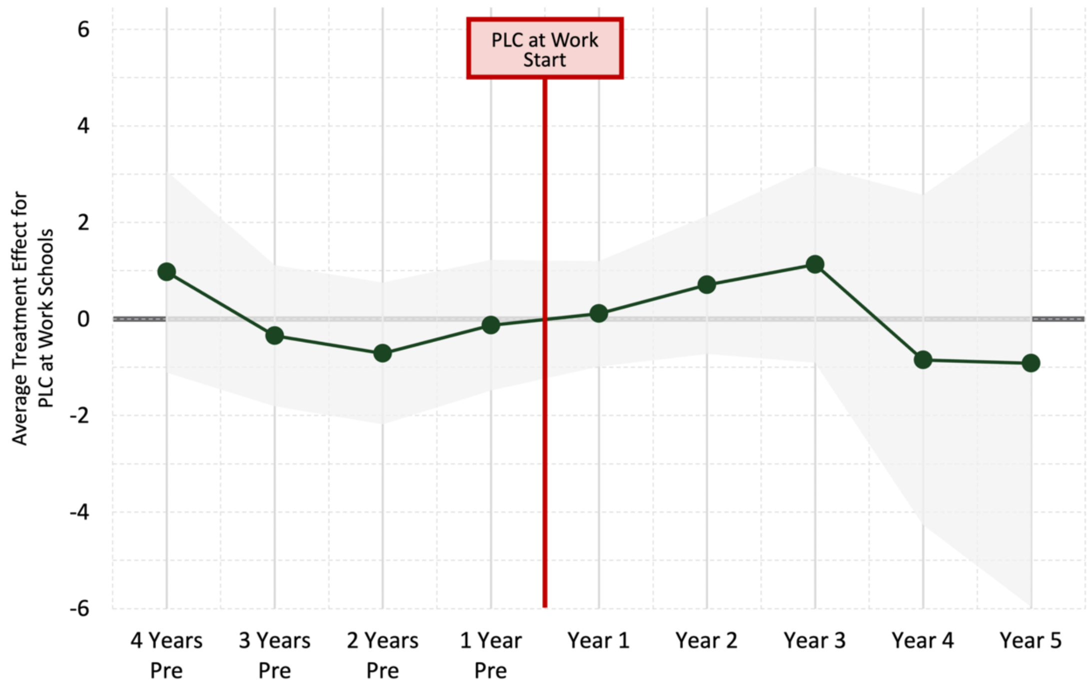
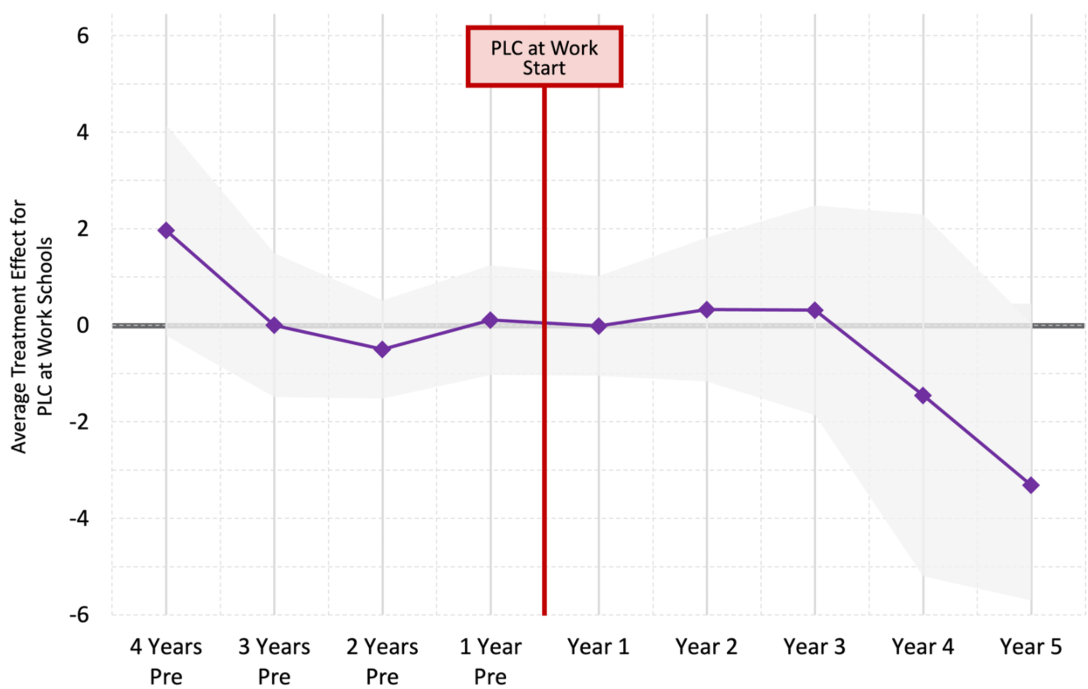


Figure 2

Combined Effects of PLC at Work on Average Weighted Achievement by Year, Economically Disadvantaged Students



Overall estimates indicate that students in PLC at Work schools demonstrated similar weighted achievement scores compared to students in comparison schools that were not selected to participate in the PLC at Work program. Economically disadvantaged students in PLC at Work schools demonstrated decreases in weighted achievement scores compared to similar students in schools that were not selected to participate in the PLC at Work program. Differences between student achievement in PLC at Work schools after participating in the program were not statistically significantly different than student achievement in non-PLC at Work schools. Nonetheless, the consistent negative associations and the substantial observed decreases, particularly for economically disadvantaged students in later years, raise concerns about the program's impact on student achievement. The findings presented in Figures 1 and 2 suggest that PLC at Work participation may not be yielding positive results for student learning outcomes.

Tables 6 and 7 provide a more detailed examination, displaying the average weighted achievement by year and cohort for the overall student population and economically disadvantaged students. The reference category for each outcome of interest is the baseline year, or one year prior to PLC at Work adoption. More simply, the event study framework can be seen as a pre post analysis exploring the outcomes of interest of each year of PLC at Work participation compared to scores the year prior to adoption.

Table 6

Effect of PLC at Work on Average Weighted Achievement by Cohort and Year, All Students

	Overall	Year 1	Year 2	Year 3	Year 4	Year 5
Cohort 1	-0.021 (2.121)	0.798 (2.208)	0.260 (0.260)	1.035 (2.640)	-0.829 (2.833)	-1.372 (2.569)
Cohort 2	-2.042 (1.420)	-2.247*** (0.794)	-1.873 (1.729)	-2.316 (1.909)	-1.732 (1.980)	
Cohort 3	1.355 (1.060)	0.803 (1.306)	1.139 (1.218)	2.123 (1.125)		
Cohort 4	-0.350 (0.688)	-1.313 (0.820)	0.613 (0.873)			
Cohort 5	-0.297 (0.895)	-0.297 (0.898)				

Standard errors in parentheses
**** p<0.01, **p<0.05, *p<0.1*

Examining the event study results by cohort and year reveals a trend of predominantly negative associations between PLC at Work participation and student achievement. For all students, fourteen out of the twenty estimates for average weighted achievement indicated negative associations. Notably, all cohorts except Cohort 3 displayed negative overall estimates for average weighted achievement compared to non-PLC at Work schools.

Cohort 3 presented a seemingly positive but statistically insignificant finding. Students in Cohort 3 PLC at Work schools exhibited a 1.355-point increase in average weighted achievement compared to their counterparts in non-PLC at Work schools. However, the lack of statistical significance renders this finding inconclusive. Similar to the overall results, the majority of estimates from the event study analysis by cohort are not statistically significant, suggesting limited evidence to support the program's effectiveness on student achievement outcomes across the various cohorts.

Table 7
Effect of PLC at Work on Average Weighted Achievement by Cohort and Year, Economically Disadvantaged Students

	Overall	Year 1	Year 2	Year 3	Year 4	Year 5
Cohort 1	-1.349	1.136	0.015	-1.073	-3.058	-3.765**
	(1.428)	(1.537)	(0.015)	(2.037)	(2.424)	(1.733)
Cohort 2	-1.912	-2.008***	-2.343	-2.460	-0.836	
	(2.032)	(0.690)	(2.392)	(2.733)	(2.891)	
Cohort 3	1.055	0.916	0.663	1.586		
	(1.109)	(1.380)	(1.205)	(1.208)		
Cohort 4	-0.823	-1.983**	0.337			
	(0.715)	(0.856)	(0.870)			
Cohort 5	-0.680	-0.680				
	(0.902)	(0.918)				

Standard errors in parentheses
**** p<0.01, **p<0.05, *p<0.1*

Similar to the findings for all students presented in Table 6, the event study analysis of economically disadvantaged students presented in Table 7 reveals a predominantly negative trend. Thirteen out of the twenty estimates for average weighted achievement indicated negative associations with PLC at Work participation.

Unlike the general student analysis, however, the results for economically disadvantaged students yielded a slightly higher number of statistically significant negative associations. For instance, in Cohort 1, economically disadvantaged students in PLC at Work schools exhibited a statistically significant (95% confidence level) decrease of 3.765 points in average weighted achievement in Year 5 compared to their counterparts in non-PLC at Work schools. Similarly, Cohort 2 displayed a statistically significant (99% confidence level) decrease of 2.008 points in average weighted achievement for economically disadvantaged students in PLC at Work schools during their first year of program participation (Year 1). Cohort 4 also presented a statistically significant (95% confidence level) decrease of 1.983 points in average weighted achievement for economically disadvantaged students in Year 1, relative to their non-PLC at Work counterparts.

In summary, the analysis of average weighted achievement raises concerns about the program's effectiveness, particularly for economically disadvantaged students. While overall estimates lacked statistical significance, a concerning pattern emerged across cohorts and years. Negative associations dominated the results, suggesting that PLC at Work participation may not yield positive results regarding student learning outcomes. These findings necessitate further investigation to understand the factors contributing to these trends and to explore potential program modifications or supplementary interventions that could enhance PLC at Work's impact on student-weighted achievement.

Overall Growth

Following the trends observed in average weighted achievement, we now explore school-level value-added growth to understand better PLC at Work's impact on student academic progress. This metric helps isolate the influence of a school's environment on academic progress, minimizing the impact of factors like socioeconomic background. By comparing a school's average student growth to students with similar historical growth patterns, we can determine whether students collectively exceeded, met, or fell short of typically expected progress. For the 2022-23 school year, the average school-level value-added growth for the combined student population was 80.08, with a standard deviation of 2.81. The average school-level value-added growth for the economically disadvantaged student population was 79.75, with a standard deviation of 2.65. Figures 3 and 4 depicts the overall findings for school value-added growth scores across all cohorts for the general student population and economically disadvantaged students, respectively.

Figure 3

Combined Effects of PLC at Work on School-Level Value-Added Growth by Year, All Students

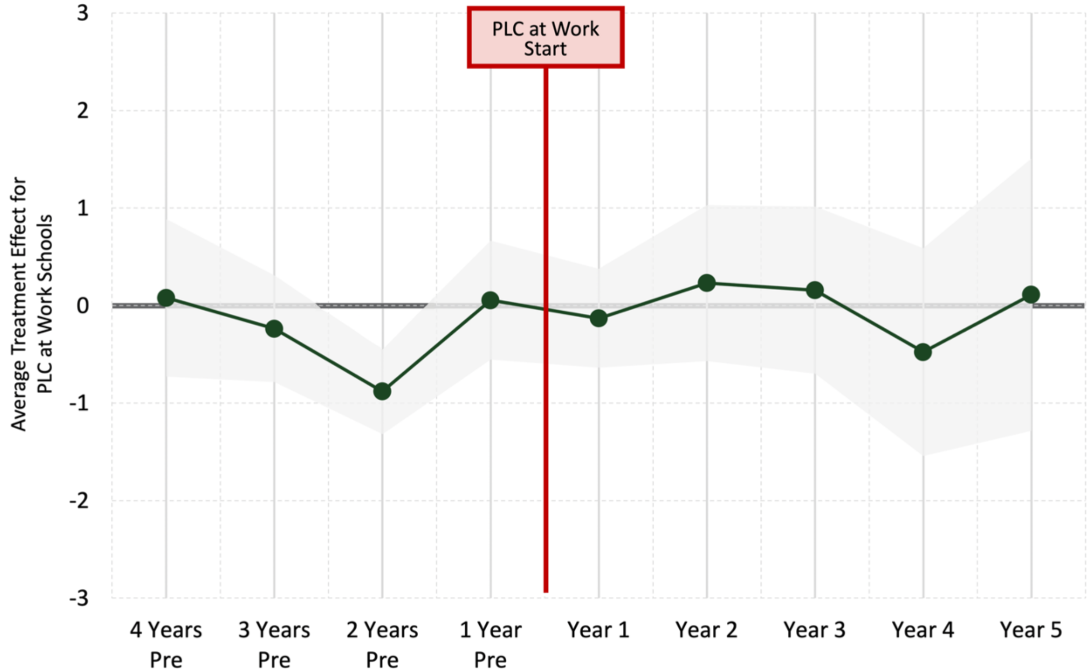
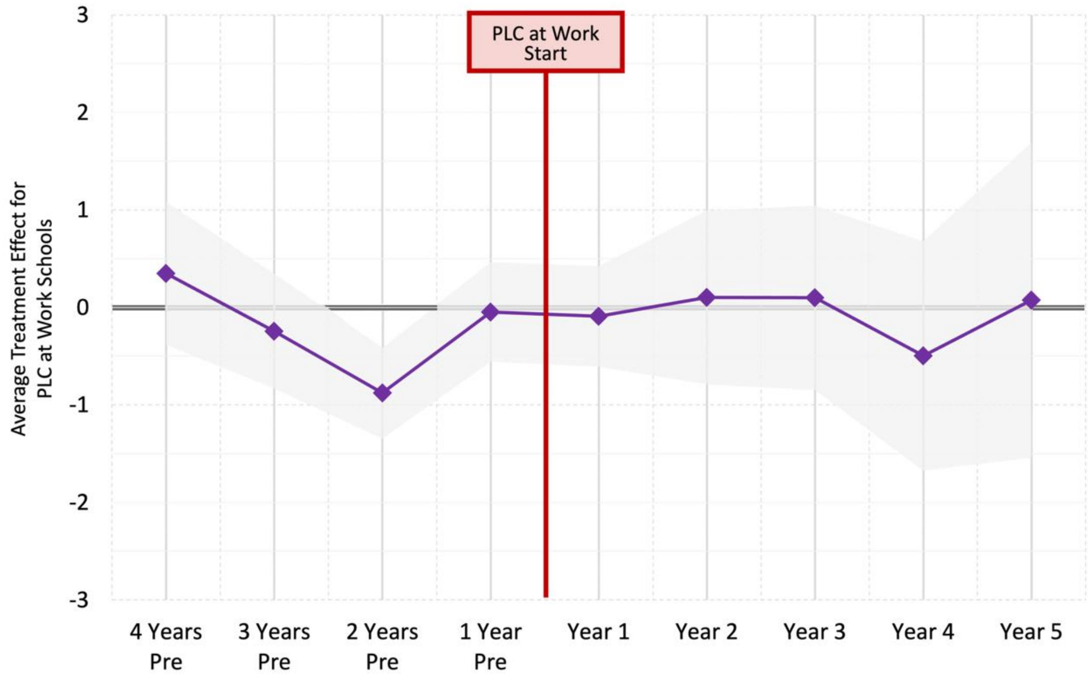


Figure 4

Combined Effects of PLC at Work on School-Level Value-Added Growth by Year, Economically Disadvantaged Students



Our analysis of student value-added growth revealed the academic growth of students in PLC at Work schools was similar to that of students in non-PLC at Work schools. Overall estimates for all students and for economically disadvantaged students indicate that differences between student growth in PLC at Work schools were not statistically significantly different than student growth in non-PLC at Work schools.

Tables 8 and 9 offer a more detailed view, presenting the growth scores by year and cohort for the general student population and economically disadvantaged students, respectively.

Table 8

Effect of PLC at Work on School-Level Value-Added Growth by Cohort and Year, All Students

	Overall	Year 1	Year 2	Year 3	Year 4	Year 5
Cohort 1	0.637 (0.578)	0.821 (0.650)	1.325* (1.325)	0.678 (0.570)	0.249 (0.686)	0.112 (0.711)
Cohort 2	-1.217* (0.657)	-1.202*** (0.403)	-1.313 (1.081)	-1.207 (0.767)	-1.145* (0.695)	
Cohort 3	0.211 (0.596)	-0.099 (0.655)	0.095 (0.592)	0.638 (0.718)		
Cohort 4	0.216 (0.662)	-0.370 (0.618)	0.801 (0.776)			
Cohort 5	0.134 (0.329)	0.134 (0.330)				

Standard errors in parentheses
**** p<0.01, **p<0.05, *p<0.1*

The event study analysis of school-level value-added growth reveals mixed findings compared to the results for average weighted achievement. While seven out of the twenty estimates indicated negative associations with PLC at Work participation, the majority were not statistically significant. The findings suggests that the general student population in PLC at Work schools did not experience statistically significant differences in value-added growth compared to their non-PLC at Work counterparts.

Cohort 2, however, displayed a pattern of negative results, with some reaching statistical significance. Specifically, the general student population in Cohort 2's PLC at Work schools exhibited a marginally statistically significant (90% confidence level) overall decrease of 1.217 points in school-level value-added growth compared to their non-PLC at Work counterparts. In Year 1 (first year of program implementation), Cohort 2 presented a statistically significant (99% confidence level) decrease of 1.202 points in value-added growth for the general student population in PLC at Work schools relative to the non-PLC at Work group. Year 4 of Cohort 2 also revealed a marginally statistically significant (90% confidence level) decrease of 1.145 points in value-added growth for the general student population in PLC at Work schools compared to their non-PLC at Work counterparts.

Table 9
Effect of PLC at Work on School-Level Value-Added Growth by Cohort and Year, Economically Disadvantaged Students

	Overall	Year 1	Year 2	Year 3	Year 4	Year 5
Cohort 1	0.715 (0.719)	1.161 (0.715)	1.457 (1.457)	0.748 (0.657)	0.137 (0.789)	0.074 (0.834)
Cohort 2	-1.354* (0.772)	-1.277*** (0.433)	-1.926* (1.162)	-1.133 (0.893)	-1.081 (0.824)	
Cohort 3	0.114 (0.622)	0.002 (0.670)	-0.102 (0.637)	0.443 (0.773)		
Cohort 4	0.268 (0.521)	-0.398 (0.476)	0.934 (0.639)			
Cohort 5	0.062 (0.378)	0.062 (0.385)				

Standard errors in parentheses
**** p<0.01, **p<0.05, *p<0.1*

The event study analysis of school-level value-added growth for economically disadvantaged students mirrors the findings for the general student population. Seven out of the twenty estimates indicated negative associations with PLC at Work participation, with the majority lacking statistical significance. The results suggest a lack of statistically significant differences in value-added growth between economically disadvantaged students in PLC at Work schools and their non-PLC at Work counterparts.

Like the general student population analysis of school-level value added growth, Cohort 2 displayed a pattern of negative associations, with some reaching statistical significance. Economically disadvantaged students in Cohort 2's PLC at Work schools exhibited a marginally statistically significant (90% confidence level) overall decrease of 1.354 points in school-level value-added growth compared to their non-PLC at Work counterparts. Furthermore, Year 1 (first year of program implementation) for Cohort 2 presented a statistically significant (99% confidence level) decrease of 1.277 points in value-added growth for economically disadvantaged students in PLC at Work schools relative to the non-PLC at Work group. Year 2 of Cohort 2 also revealed a marginally statistically significant (90% confidence level) decrease of 1.929 points in value-added growth for economically disadvantaged students in PLC at Work schools compared to their non-PLC at Work counterparts.

This examination of school-level value-added growth yielded mixed findings regarding the effectiveness of PLC at Work in promoting student academic progress. While overall estimates lacked statistical significance, a concerning pattern emerged, particularly for schools in Cohort 2.

English Language Arts Growth

Building upon the analysis of overall school-level value-added growth, this section and the next further examine student progress within specific academic domains: English Language Arts (ELA) and mathematics. Weighted average achievement scores lack subject disaggregation, hindering a comprehensive analysis of subject-specific achievement, attempts to calculate subject-level achievement were unsuccessful due to reporting limitations.

Available data for value-added growth, however, is readily available in a subject-disaggregated format, offering valuable insights into student progress within core subjects. Figure 5 and 6 explores school ELA value-added growth scores, providing a comprehensive overview of year over-year trends for both the general student population and economically disadvantaged students, respectively. The data is presented on a year-by-year basis to facilitate comparisons.

Figure 5

Combined Effects of PLC at Work on ELA School-Level Value-Added Growth by Year, All Students

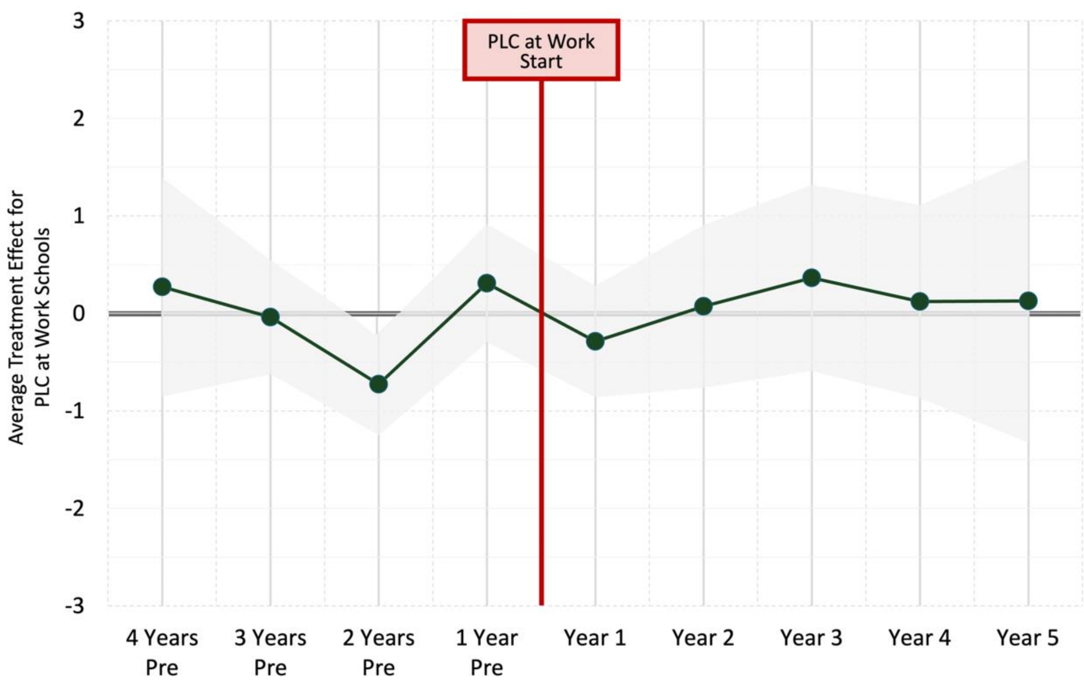
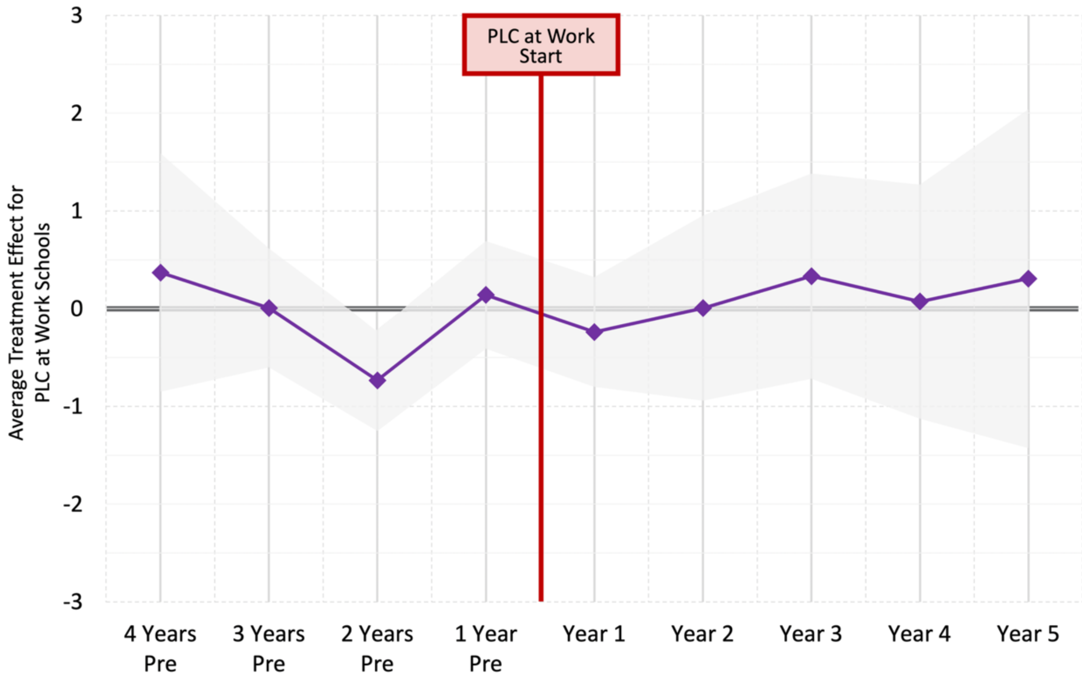


Figure 6

Combined Effects of PLC at Work on ELA School-Level Value-Added Growth by Year, Economically Disadvantaged Students



With overall estimates hovering close to zero on the Y-axis, the results indicate that students in PLC at Work schools demonstrated similar value-added growth scores in ELA compared to students in comparison schools that were not selected to participate in the PLC at Work program. The results are similar for both student groups of interest. Additionally, differences between school-level value-added growth in PLC at Work schools after participating in the program were not statistically different than school-level value-added growth in ELA at non-PLC at Work schools. The findings presented in Figures 5 and 6 suggest that PLC at Work participation may not be yielding positive results for student learning outcomes.

Tables 10 and 11 provide a more detailed examination, displaying the school-level value-added growth scores in ELA by year and cohort for the overall student population and economically disadvantaged students, respectively. The reference category for each outcome of interest is the baseline year, or one year prior to PLC at Work adoption.

Table 10
Effect of PLC at Work on ELA School-Level Value-Added Growth by Cohort and Year, All Students

	Overall	Year 1	Year 2	Year 3	Year 4	Year 5
Cohort 1	0.657 (0.620)	0.624 (0.790)	0.925 (0.925)	0.800 (0.610)	0.806 (0.632)	0.128 (0.742)
Cohort 2	-0.904 (0.694)	-1.142* (0.473)	-1.356 (1.107)	-0.603 (0.748)	-0.514 (0.671)	
Cohort 3	0.198 (0.761)	-0.149 (0.768)	0.074 (0.777)	0.670 (0.858)		
Cohort 4	-0.101 (0.559)	-0.731 (0.561)	0.528 (0.647)			
Cohort 5	-0.082 (0.370)	-0.082 (0.370)				

Standard errors in parentheses
*** p<0.01, **p<0.05, *p<0.1*

Similar to the overall school-level value-added growth results presented earlier, the event study analysis of ELA growth reveals no statistically significant evidence of positive program effects for the general student population in PLC at Work schools. Half of the estimates indicated negative associations with PLC at Work participation, and all but two estimates were less than one point. These findings suggest that the general student population in PLC at Work schools experienced similar average growth in ELA compared to their counterparts in non-PLC at Work schools.

Consistent with the overall value-added growth results, students Cohort 2 displayed the most consistent pattern of negative associations in ELA growth. For Cohort 2, all estimates for the general student population's school-level value-added growth in ELA since program adoption were negative. This translates to an overall negative estimate, suggesting that students in Cohort 2 PLC at Work schools exhibited a 0.904-point decrease in school-level value-added growth in

ELA compared to their non-PLC at Work counterparts. However, only one estimate reached statistical significance, marginal significance (90% confidence level) in Year 1 of Cohort 2.

Table 11
Effect of PLC at Work on ELA School-Level Value-Added Growth by Cohort and Year, Economically Disadvantaged Students

	Overall	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Cohort 1	0.887 (0.838)	0.998** (0.862)	1.353 (1.353)	0.907 (0.800)	0.868 (0.812)	0.308 (0.895)
Cohort 2	-1.028 (0.773)	-1.099 (0.432)	-1.782 (1.257)	-0.566 (0.865)	-0.663 (0.770)	
Cohort 3	0.029 (0.748)	-0.157 (0.717)	-0.287 (0.770)	0.532 (0.906)		
Cohort 4	0.110 (0.376)	-0.567 (0.402)	0.788 (0.496)			
Cohort 5	-0.226 (0.500)	-0.226 (0.509)				

Standard errors in parentheses
**** p<0.01, **p<0.05, *p<0.1*

The event study analysis of school-level value-added growth in ELA for economically disadvantaged students mirrors the trends observed for the general student population. Half of the estimates indicated negative associations with PLC at Work participation, and all but one estimate lacked statistical significance. Furthermore, all but three estimates were less than one point. These findings suggest that economically disadvantaged students in PLC at Work schools experienced similar average growth in ELA compared to their counterparts in non-PLC at Work schools.

Table 11 presents one noteworthy finding. Economically disadvantaged students in Cohort 1 exhibited a statistically significant (95% confidence level) increase of 0.998 points in school-level value-added growth in ELA compared to their non-PLC at Work counterparts. However, it is important to consider the magnitude of this effect. With a value less than one standard deviation, this finding suggests a modest improvement that is not seen reflected in other Cohorts.

Math Growth

Finally, school-level math value-added growth scores are explored in Figures 7 and 8 Tables 12 and 13 below. Figure 4 presents a comprehensive year-by-year analysis of these scores for all student groups, including both the general student population and economically disadvantaged students.

Figure 7

Combined Effects of PLC at Work on Math School-Level Value-Added Growth by Year, All Students

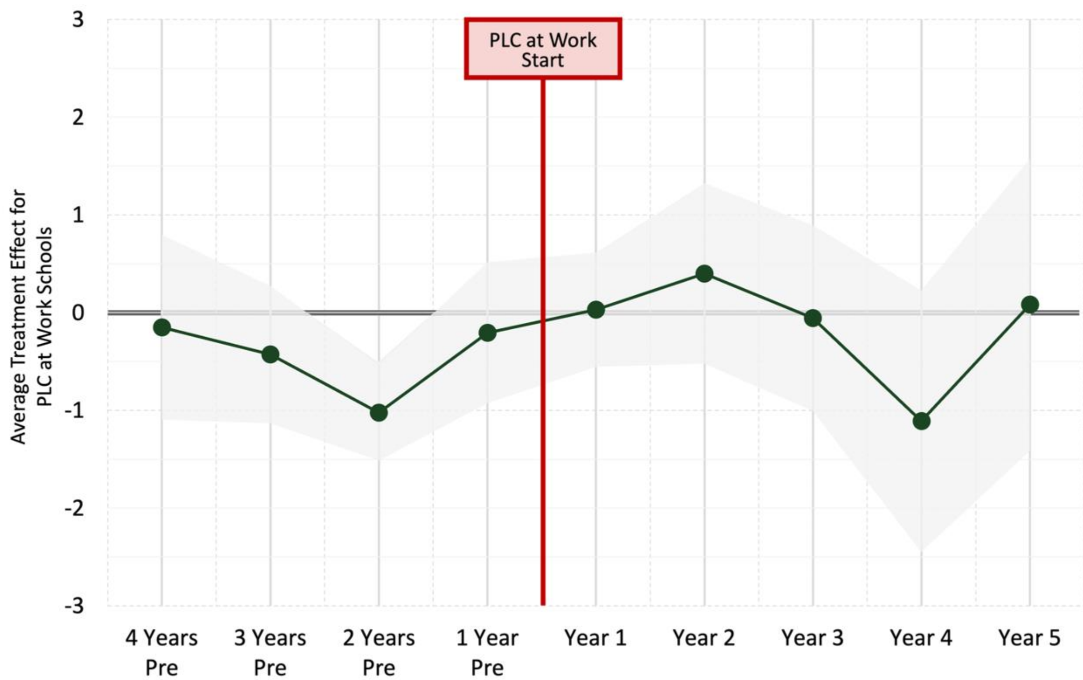
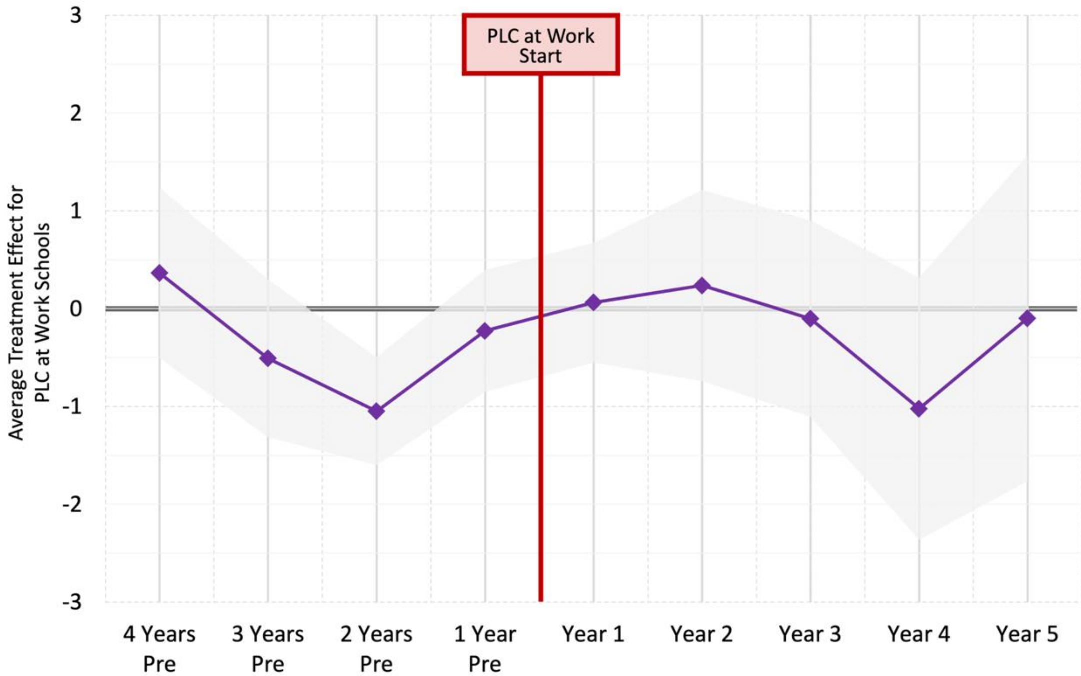


Figure 8
Combined Effects of PLC at Work on Math School-Level Value-Added Growth by Year, Economically Disadvantaged Students



Like the findings for other student growth outcomes, the event study analysis of school-level value-added growth in math revealed no statistically significant program effects for either the general student population or economically disadvantaged students in PLC at Work schools. Most estimates hovered near zero and lacked statistical significance. This suggests that, on average, both student groups in PLC at Work schools experienced similar value-added growth in math compared to their counterparts in non-PLC at Work schools.

It is noteworthy, however, that there was a sharp decrease in math growth scores four years after program implementation for both student groups. It is important to acknowledge that data for Year 4 is limited, as it only includes information from Cohorts 1 and 2. Tables 12 and 13 disaggregate the math growth scores by year and cohort for a more detailed examination. Table

12 focuses on the general student population, while Table 13 specifically examines scores for economically disadvantaged students.

Table 12
Effect of PLC at Work on Math School-Level Value-Added Growth by Cohort and Year, All Students

	Overall	Year 1	Year 2	Year 3	Year 4	Year 5
Cohort 1	0.625 (0.698)	1.022 (0.723)	1.816** (0.925)	0.371 (0.733)	-0.215 (0.962)	0.133 (0.768)
Cohort 2	-1.885** (0.738)	-1.648*** (0.804)	-1.617 (1.198)	-2.290** (1.075)	-2.274** (1.095)	
Cohort 3	-1.207 (0.895)	-1.838* (1.067)	-2.741** (1.255)	-1.825 (1.593)		
Cohort 4	-0.111 (0.765)	-1.518 (1.010)	-0.817 (0.916)	-0.790 (1.298)		
Cohort 5	0.016 (0.382)	0.016 (0.382)				

Standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

In contrast to the findings for overall and ELA growth, the event study analysis of school-level value-added growth in math revealed a pattern of statistically significant associations, albeit with mixed directionality (positive and negative) and larger effect sizes (compared to other growth outcomes). Fourteen out of the twenty estimates indicated negative associations with PLC at Work participation, and twelve estimates exceeded one point in absolute value. Furthermore, seven estimates reached statistical significance.

Cohort 1 displayed the most consistent positive trends. Overall, students in Cohort 1 PLC at Work schools exhibited a 0.625-point increase in math growth scores compared to their non-PLC counterparts, although this increase lacked statistical significance. The most notable positive association for Cohort 1 occurred in Year 2, with a statistically significant (95% confidence level) increase of 1.816 points in school-level value-added growth in math. However, following Year 2, Cohort 1 experienced a decline in scores, even falling below their non-PLC counterparts in Year 4. The latter results were not statistically significant.

In contrast, Cohort 2 displayed a pattern of statistically significant negative associations. On average, students in Cohort 2 PLC at Work schools experienced a statistically significant (95% confidence level) decrease of 1.885 points in math growth compared to their non-PLC counterparts. This negative overall result for Cohort 2 was driven by consistently negative estimates across years. Year 1 of PLC at Work adoption for Cohort 2 was associated with a statistically significant (99% confidence level) decrease of 1.648 points in school-level value-added growth in math. Year 2 showed a similar decline, though not statistically significant. Years 3 and 4 presented statistically significant (95% confidence level) decreases of 2.290 points and 2.274 points, respectively, in school-level value-added growth in math for students in Cohort 2 PLC at Work schools. These latter estimates approach a one standard deviation decrease.

Table 13
Effect of PLC at Work on Math School-Level Value-Added Growth by Cohort and Year, Economically Disadvantaged Students

	Overall	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Cohort 1	0.582 (0.720)	1.303* (0.674)	1.633 (1.633)	0.614 (0.724)	-0.540 (0.948)	-0.098 (0.860)
Cohort 2	-1.645* (0.868)	-1.442** (0.663)	-2.020 (1.267)	-1.651* (0.998)	-1.468 (0.957)	
Cohort 3	0.231 (0.592)	0.190 (0.742)	0.125 (0.639)	0.378 (0.765)		
Cohort 4	0.431 (0.737)	-0.224 (0.707)	1.085 (0.853)			
Cohort 5	0.346 (0.481)	0.346 (0.490)				

Standard errors in parentheses
**** p<0.01, **p<0.05, *p<0.1*

The event study analysis of school-level value-added growth in math for economically disadvantaged students revealed a less pronounced pattern of negative associations compared to the general student population. Only eight out of the twenty estimates indicated negative associations with PLC at Work participation, and eight estimates exceeded one point in absolute value. Furthermore, just three estimates reached statistical significance.

Similar to the general student population analysis, all cohorts except Cohort 2 displayed positive overall estimates for economically disadvantaged students. However, these positive estimates were modest and lacked statistical significance. Cohort 2, however, mirrored the negative trends observed for the general student population. Overall, economically disadvantaged students in Cohort 2 PLC at Work schools exhibited a marginally statistically significant (90% confidence level) decrease of 1.645 points in math growth compared to their non-PLC counterparts. This negative association was driven by consistently negative estimates across years. Year 1 of PLC at Work adoption for Cohort 2 was associated with a statistically significant (95% confidence level) decrease of 1.442 points in school-level value-added growth in math for economically disadvantaged students. Year 2 showed a decline that was not statistically significant, while Year 3 presented a marginally statistically significant (90% confidence level) decrease of 1.651 points.

VI. Conclusions

This study investigates the association between student achievement and growth in schools partnered with Solution Tree as Professional Learning Communities (PLCs) at Work. We employed multiple evaluation methods to identify positive effects, but the results provided limited evidence to support the program's overall effectiveness. We found no statistically significant differences in student performance between PLC at Work and non-PLC schools, measured by average weighted achievement and school-level value-added growth. However, a concerning trend emerged, particularly for economically disadvantaged students. There were negative associations between PLC at Work participation and student achievement scores across cohorts and years.

The analysis of student growth yielded mixed findings. While overall estimates for school-level value-added growth lacked statistical significance, Cohort 2 consistently displayed negative associations, with some reaching significance in both ELA and math. Interestingly, a sharp decrease in math growth scores was observed for both student groups four years after program implementation. Findings varied by cohort. While Cohort 1 exhibited a temporary, statistically significant positive association in school-level ELA growth during Year 2, it did not persist in subsequent years. Conversely, Cohort 2 displayed a consistent pattern of negative associations across all outcomes.

Overall, these findings raise concerns about the effectiveness of the PLC at Work program, particularly for economically disadvantaged students and in math growth. Further research is crucial to explore the reasons behind the observed negative associations, especially for Cohort 2. Additionally, investigating potential program modifications or supplementary interventions that could enhance PLC at Work's impact on student learning outcomes is essential.

Limitations

This study has several limitations that should be considered when interpreting the findings. One significant limitation is the potential for selection bias due to the non-random assignment of schools to the PLC at Work program. Schools that applied and were selected to participate may differ systematically from schools that did not, introducing potential confounding variables that could influence the results. Although we employed propensity score matching to mitigate this bias, we must recognize that our findings should not be interpreted as causal.

Additionally, the comparison schools in our analysis may have implemented parts of Solution Tree's PLC model or similar professional development initiatives without being formally designated as PLC at Work schools. This possibility introduces a dilution effect. Since comparison schools might also be benefiting from collaborative practices and professional development resources that align with PLC principles, the observed differences in student outcomes between PLC at Work schools and comparison schools could be less pronounced. Ideally, the comparison group would have had no exposure to similar initiatives, allowing for a clearer picture of the PLC at Work program's isolated impact.

The study also did not control for all possible confounding variables related to student or school characteristics, such as specific instructional practices, school leadership quality, or community support structures. While our analysis focused on core associations between PLC at Work participation and student outcomes, the variability in school contexts across Arkansas, including demographics, socioeconomic status, and prior achievement levels, could influence the results. Thus, our findings provide a general picture rather than a definitive assessment of the program's impact.

Finally, the program's implementation fidelity across different schools and cohorts was not directly measured. Variations in how well the PLC at Work model was implemented could influence the outcomes observed. Schools with higher fidelity to the program's principles and practices might experience different results than those with lower fidelity, affecting the overall effectiveness of the initiative.

While this study provides valuable insights into the association between PLC at Work participation and student outcomes, the limitations highlight the need for cautious interpretation and further research. Future studies should address these limitations by incorporating more rigorous controls, exploring the effects of implementation fidelity, and considering a broader range of educational outcomes.

Policy Recommendations

This study's findings and the wider context of the Arkansas PLC at Work program suggest several detailed policy recommendations to improve program effectiveness and address concerns.

Enhanced Transparency from Solution Tree

We recommend increased data collection and transparency from the PLC at Work program provider, Solution Tree, to strengthen program evaluation and accountability. Currently, data collection efforts within the program lack a standardized and centralized approach, making it challenging for policymakers and school stakeholders to objectively assess the program's effectiveness and identify areas for improvement.

Therefore, we propose that Solution Tree implement a standardized data collection system across all participating schools with data available for the public and relevant stakeholders. This system should mirror the one recommended for schools, capturing student achievement data disaggregated by subgroups like disadvantaged students. Increased transparency would enable DESE to conduct comprehensive program evaluations and provide policymakers with a clearer picture of the program's impact on student achievement across the state. Furthermore, school stakeholders, including educators and parents, would gain valuable insights into the program's effectiveness in their schools and the participating districts.

Strengthened Oversight and Accountability

Ensuring the long-term success of PLC at Work necessitates a stronger emphasis on oversight and accountability. Regular independent evaluations, conducted by unbiased outside researchers, are crucial to assess program effectiveness and its impact on diverse student groups. Evaluations should consider implementation fidelity, cost-effectiveness, and student academic outcomes. Additionally, promoting transparency in resource allocation and financial management through measures like detailed expenditure reports to the Arkansas Department of Education will foster greater accountability. Prioritizing these measures will provide valuable insights to stakeholders and ensure that the program effectively serves Arkansas students and teachers.

Audit of PLC at Work Program Effectiveness

A comprehensive, independent audit is recommended to optimize the PLC at Work program in Arkansas. This audit should focus on maximizing the impact of Solution Tree's on-site support (50 days annually). The audit could examine schedules and activity logs to assess time utilization and conduct stakeholder interviews to identify potential gaps between planned activities and school needs. Optimizing support distribution across schools is also essential. The audit should investigate current practices and explore alternative models, ensuring resource allocation aligns with factors like school size and student demographics. Finally, teacher perceptions are vital. The audit should incorporate surveys or focus groups to evaluate the provided resources' helpfulness and alignment with PLC needs. Additionally, it should assess teacher access to alternative professional development opportunities. By addressing these critical areas, the audit can provide valuable insights to enhance program effectiveness and ensure PLC at Work offers impactful support for Arkansas educators.

In conclusion, this study sheds light on a complex issue: the association between participation in the PLC at Work program and student academic achievement in Arkansas. While the PLC at Work model demonstrates promise in enhancing professional development and educational practices, the findings from our study indicate that its current implementation in Arkansas has not resulted in significant improvements in student academic outcomes. While these results do not definitively establish causality due to limitations like selection bias and potential dilution effects from similar initiatives in comparison schools, they raise significant questions about the program's effectiveness in its current form. Further research employing more rigorous controls and exploring implementation fidelity is necessary to understand the program's impact definitively. Ultimately, the goal is to ensure that all students in Arkansas, regardless of background, benefit from the collaborative and professional learning opportunities offered by PLCs. This study serves as a crucial starting point for ongoing evaluation and refinement, paving the way for a future where the PLC at Work program becomes a powerful tool for advancing student achievement across the state.

VII. References

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VIII. Appendix

Table 1.A

Cohort 1 PLC at Work Schools with Baseline Demographic Data, 2016-17

School Name	District	Enrollment	% FRL	% SPED	% ELL	% White	% Proficient ELA	% Proficient Math
Ballman Elementary	Fort Smith	302	73	15	22	52	46	44
Bragg Elementary	West Memphis	535	100	8	00	47	31	50
Douglas MacArthur Junior High	Jonesboro	670	100	14	08	44	43	38
Frank Mitchell Intermediate	Vilonia	757	47	17	2	92	62	63
Greenbrier Eastside Elementary	Greenbrier	415	53	14	2	92	70	69
Monticello Middle School	Monticello	388	56	11	1	60	58	54
Morrilton Intermediate	S. Conway County	501	100	12	4	71	57	63
Prescott Elementary School	Prescott	542	100	12	5	54	34	52
Prescott High School	Prescott	457	100	11	2	54	45	24
Rogers High School	Rogers	2044	49	10	31	49	59	30
Spradling Elementary	Fort Smith	451	98	13	52	19	42	49

Table 2.A
Cohort 2 PLC at Work Schools with Baseline Demographic Data, 2017-18

School Name	District	Enrollment	% FRL	% SPED	% ELL	% White	% Proficient ELA	% Proficient Math
Blytheville Primary School	Blytheville	562	100	10	5	13	NA	NA
Cabe Middle School	Gurdon	222	74	14	9	53	33	32
East Pointe Elementary	Greenwood	642	43	14	1	82	59	76
Greer Lingle Middle School	Rogers	930	65	15	24	52	57	57
Gurdon High School	Gurdon	202	67	13	3	51	34	13
Gurdon Primary	Gurdon	286	77	12	12	53	19	23
Hamburg High School	Hamburg	575	54	8	7	60	36	23
Howard Perrin Elementary	Benton	594	39	10	1	86	60	67
Main Street Arts Magnet	Hot Springs	614	93	15	6	31	35	49
Murrell Taylor Elementary	Jacksonville N. Pulaski	524	00	19	2	22	17	31
Quitman Elementary School	Quitman	356	64	22	1	93	58	58
Quitman High School	Quitman	320	47	14	1	94	50	47
Rivercrest Elementary	Rivercrest	608	83	9	1	60	46	49

Table 3.A
Cohort 3 PLC at Work Schools with Baseline Demographic Data, 2018-19

School Name	District	Enrollment	% FRL	% SPED	% ELL	% White	% Proficient ELA	ELA
Academies at Rivercrest	Rivercrest	570	66	0.1	1	65	31	21
Bayyari Elementary	Springdale	569	92	9	61	11	26	38
Buffalo Island Central Elementary	Buffalo Island Central	382	61	15	11	78	51	65
Buffalo Island Central High	Buffalo Island Central	342	49	13	10	82	45	4
Camden Fairview High School	Camden Fairview	643	66	1	2	31	26	14
Camden Fairview Intermediate	Camden Fairview	384	82	12	2	34	28	32
Centerpoint High School	Centerpoint	519	68	11	12	78	41	4
Clinton Elementary School	Clinton	445	75	19	13	76	44	66
Clinton Elementary School	Clinton	562	100	18	5	88	52	62
Clinton Junior High	Clinton	299	100	17	0	95	63	61
Crossett High School	Crossett	502	5	10	2	62	32	22
Darby Middle School	Fort Smith	628	93	16	28	26	4	33
Eureka Springs Elementary	Eureka Springs	229	67	18	9	90	44	64
Harrisburg High School	Harrisburg	375	100	13	2	93	29	24
Jacksonville Elementary	Jacksonville N. Pulaski	365	100	12	4	31	35	42
Lake Hamilton Intermediate	Lake Hamilton	730	58	11	4	78	48	65
Lake Hamilton Junior High	Lake Hamilton	725	52	9	5	79	49	47
Lakeside High School	Lakeside (Garland)	262	100	11	5	13	34	15
Mabelvale Elementary	Little Rock	524	94	11	23	7	17	27
Mills Univ. Studies High School	Pulaski County	598	68	12	1	22	22	12
Northside High School	Fort Smith	1691	79	10	36	25	35	22
Park Avenue Elementary	Stuttgart	604	100	17	6	37	23	47
Valley Springs Elementary	Valley Springs	314	5	12	0	96	52	60
Watson Elementary	Little Rock	494	93	11	29	2	7	13
Wonderview Elementary	Wonderview	268	68	19	0	94	42	51

Table 4.A

Cohort 4 PLC at Work Schools with Baseline Demographic Data, 2020-21

School Name	District	Enrollment	% FRL	% SPED	% ELL	% White	% Proficient ELA	% Proficient Math
Arkansas High School	Texarkana	1069	100	11	1	34	26	16
Booker T. Washington Elementary	Little Rock	376	100	21	1	4	10	11
Camden Fairview Middle	Camden Fairview	564	100	11	1	28	19	7
Carver Steam Magnet Elementary	Little Rock	210	100	23	7	7	10	17
Glenview Elementary	North Little Rock	263	100	22	4	4	6	10
Hellstern Middle School	Springdale	786	49	10	17	56	56	57
Howard Elementary	Fort Smith	304	95	11	48	18	21	23
Lake Hamilton Middle School	Lake Hamilton	686	58	10	4	74	52	59
Leslie Intermediate School	Searcy County	180	100	14	1	94	37	47
Leverett Elementary School	Fayetteville	227	58	15	11	57	31	51
Magazine Elementary School	Magazine	267	79	13	0	95	36	41
Magazine High School	Magazine	253	79	15	1	90	26	22
Marshall Elementary School	Searcy County	206	100	17	0	96	38	60
Marshall High School	Searcy County	342	100	8	0	94	43	27
Meekins Middle School	Stuttgart	250	100	16	5	39	21	35
Oaklawn STEM Magnet Elem.	Hot Springs	542	100	19	12	41	19	28
Parson Hills Elementary	Springdale	418	97	11	69	9	14	25
University Heights Elementary	Nettleton	384	100	16	12	31	NA	NA

Table 5.A
Cohort 5 PLC at Work Schools with Baseline Demographic Data, 2021-22

School Name	District	Enrollment	% FRL	% SPED	% ELL	% White	% Proficient ELA	% Proficient Math
Berryville Elementary School	Berryville	432	76	14	25	63	NA	NA
Berryville High School	Berryville	545	66	15	14	64	40	19
Berryville Intermediate School	Berryville	403	71	20	19	62	35	47
Berryville Middle School	Berryville	438	73	20	15	64	42	36
Cabot Freshman Academy	Cabot	856	33	11	2	82	53	44
Carlisle Elementary School	Carlisle	325	66	14	5	78	30	35
Carlisle High School	Carlisle	288	63	13	3	81	32	19
Chicot Elementary	Little Rock	591	100	17	40	5	19	19
Greenwood Freshman Center	Greenwood	331	25	14	1	83	69	45
Greenwood High School	Greenwood	874	23	13	2	86	57	41
Hamburg Middle School	Hamburg	381	67	12	12	58	40	33
Hot Springs World Class High	Hot Springs	733	100	15	9	37	28	9
Lakeside Junior High	Springdale	644	87	13	37	20	20	22
Marked Tree Elementary School	Marked Tree	261	85	17	2	61	35	47
Marked Tree High School	Marked Tree	236	81	12	0	58	26	18
Mountainburg Elementary School	Mountainburg	223	100	22	0	94	35	46
Mountainburg High School	Mountainburg	201	100	14	0	90	44	18
Mountainburg Brain Academy	Mountainburg	199	100	22	1	91	40	38
Norphlet Middle School	Smackover-Norphlet	325	56	7	1	76	38	33
Oakland Heights Elementary	Russellville	429	79	21	35	40	28	28
Smackover Elementary School	Smackover-Norphlet	378	61	11	2	77	33	44
Smackover High School	Smackover-Norphlet	316	49	8	1	72	35	18
Sonora Middle School	Springdale	645	87	16	38	21	27	32