

Enabling Analytics for Improvement:

Lessons from Year 2 of Fresno's Personalized Learning Initiative

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Introduction

Fresno Unified School District embarked on a Personalized Learning Initiative (PLI) in 2016. Now having completed its second full year of implementation, we have clear evidence that the initiative is succeeding in helping teachers and students develop the skills, competencies and mindsets essential for “as yet imagined” futures. A unique aspect of Fresno’s PLI is its analytics partnership between Fresno Unified, Microsoft Education, Houghton Mifflin Harcourt and Digital Promise. This partnership uses learning analytics to see where and how the initiative is working, and how we can improve the initiative for greater impact.

This paper describes the early success of the PLI on students’ learning outcomes, evidence on what elements of the implementation are working, and the process and principles of our analytics partnership. The aim of the paper is to share with other education systems what we have learned on this journey.

What is Fresno's Personalized Learning Initiative?

"I think students have a lot more opportunities to have genuine learning experiences with PLI... they have authentic experiences and teamwork, cooperation, time to work things out... And different opportunities."

- Fresno PLI Teacher, 2018

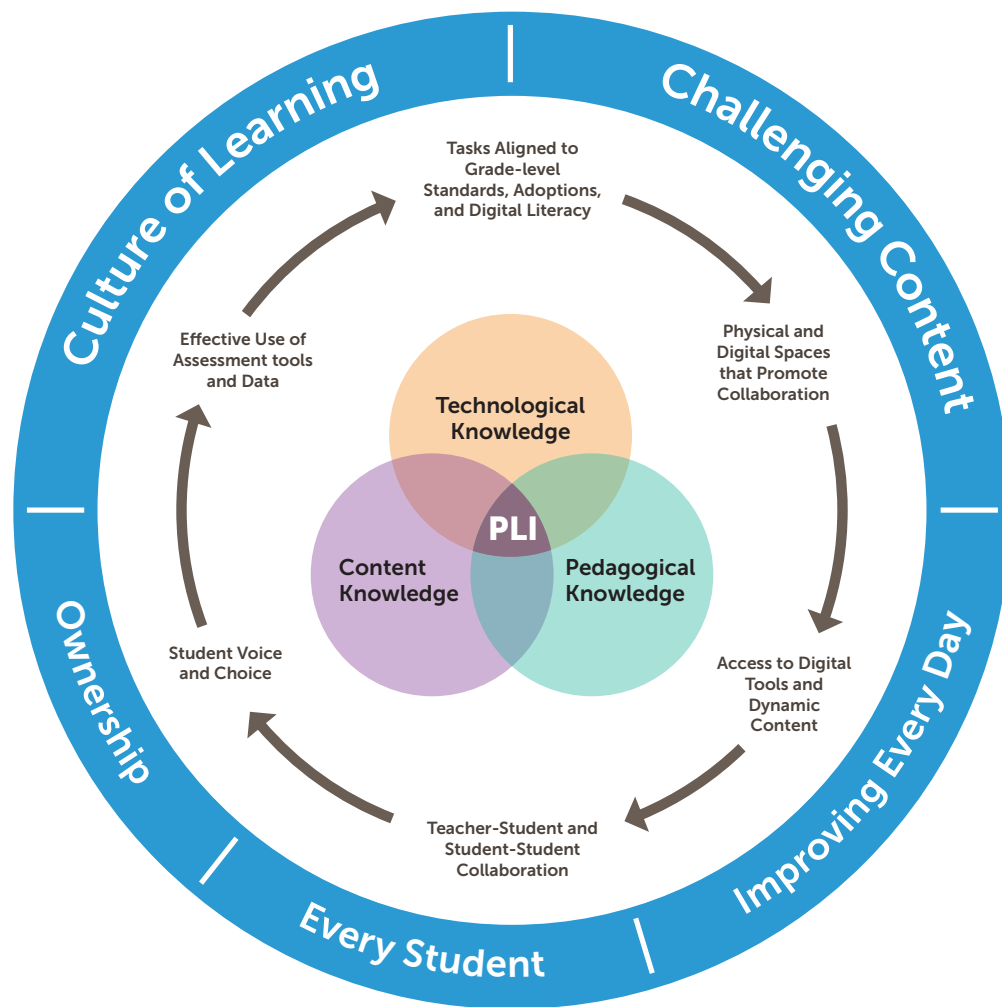
PLI is based on a pedagogical model designed to foster a collaborative learning culture where teachers and students take ownership over their own learning.

Pedagogical shifts toward the PLI model start with teachers participating in targeted professional development activities in which teachers are introduced to digital tools for designing new learning experiences that emphasize student voice, choice and collaboration. Teachers engage in professional learning through collaborative, practice-based learning sessions and ongoing communities of practice. They also have access to a broad range of support structures for designing lessons that leverage the digital learning tools available in Fresno's schools.

From its inception, PLI leaders wanted to ensure a focus on continuous improvement, not just among students and teachers, but among school and district leaders. This focus led to Fresno developing a partnership with Microsoft Education, Digital Promise, and Houghton Mifflin Harcourt to 1) leverage the data that personalized learning enables, 2) provide insights into how the PLI was being implemented in classrooms, and 3) see what

impact the initiative was having on students. [Year 1 PLI Report](#) presented early analytics results, examining instructional practices, effective use of digital tools, and student learning outcomes. Data showed Year 1 PLI teachers used more collaborative learning in their classrooms, more use of technology for giving students rapid feedback and formative assessments, and greater overall use of digital applications to design learning activities. Additionally, [an addendum](#) to the Year 1 report provided evidence of PLI's association with enhanced learning outcomes on the Smarter Balanced Assessment Consortium (SBAC) tests for English language arts and mathematics. Also described in the addendum are exploratory analyses of Houghton Mifflin Harcourt (HMH) math software that has been used districtwide in some grades.

This report shares findings from Year 2 of PLI based on analytics from the 2017-18 school year. It is a story of successes at multiple layers of Fresno's education system, but also



of clear opportunities for further deepening and broadening PLI’s impact on student learning. As one of the highest poverty districts in the US, with historic challenges in raising achievement levels, Fresno’s demonstration of improvement through the PLI offers important lessons for large urban systems across the US and the world. At the same time, we acknowledge that this is only the beginning of the PLI story. Expanding this initiative’s impact to all 71,000 students in Fresno Unified remains a daunting, yet exciting, prospect. Below we share evidence on how the PLI is helping students, particularly historically disadvantaged students, gain the competencies and confidence to succeed in their own “as yet

imagined” futures. The District’s Graduate Profile grounds student success in these competencies: responsible and ethical decision maker, creative and adaptable learner, skilled communicator and collaborator, adaptable and productive problem solver, and digitally literate citizen. We also share how the PLI’s professional development elements were aligned with the district’s goals, standards, and curricula to effectively drive changes in teaching practices at scale. Finally, we share the account of how we created our analytics partnership, what we have learned about leveraging data effectively for continuous improvement, and where we are going next.

Year 2 Impacts of PLI Implementation

Since its first year of implementation, Fresno's PLI has grown in both size and scope. In its first year, 220 teachers and 12,000 students were touched by the PLI; in Year 2 this number increased to 362 teachers and 17,045 students. PLI teachers applied to the program from schools across the district and were selected randomly within that application pool.¹

To more deeply catalyze the implementation of PLI principles within schools, Fresno Unified started the PLI Partner Site Schools in 2017-18. Schools engaged PLI Partner status which required having a minimum of 4 PLI teachers. Partner schools received PLI professional development from the district as well as 1:1 devices for PLI classrooms. In Year 2, Fresno Unified added a second PLI Cohort to continue expanding the work at elementary sites, and in many cases, layering PLI experiences for students. Fresno leadership also designated a subset of PLI teachers as "Exemplars" of PLI teaching based on growth of SBAC scores from years 1-2 of the initiative.. In addition to being recognized by school leadership as being exemplary, PLI teachers routinely shared their instructional practices and were open to classroom visits from those wanting a closer look at their pedagogical approach.

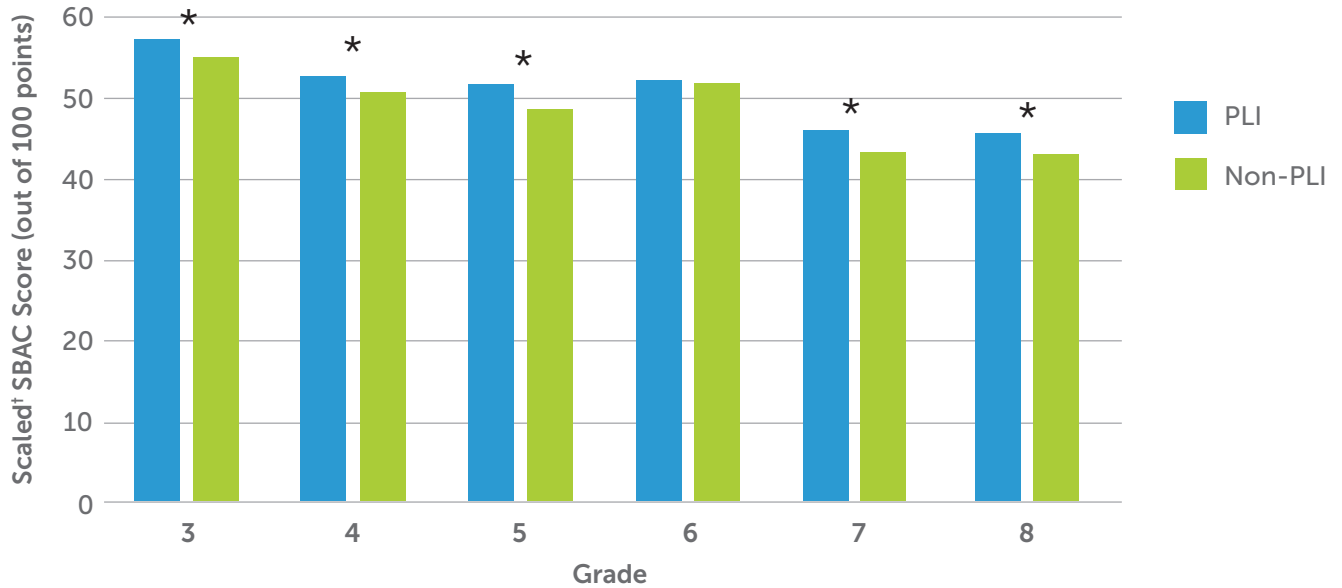
(SBAC) in English language arts (ELA) and mathematics, and on PLI students' level of digital collaboration. Figures 1 and 2 show the increase in ELA and math 2018 SBAC Scores for PLI students relative to non-PLI students after adjusting for prior 2017 SBAC scores², ethnicity, gender, ELL status, low income, homelessness, special education status, parent education, grade and attendance rates as well as variation in school climate between schools. As the figures show, PLI students outscored their non-PLI peers on these assessments in grades 3, 4, 5, 7 and 8 on ELA assessments, and in grades 3, 4, 5, 6 and 8, on math assessments (SBAC assessments are not given for grades 9, 10, and 12, and thus grade 11 SBAC scores could not be adjusted for prior achievement.)

Data analyses for Year 2 show strong evidence that the PLI's positive impact on learning in Year 1 continued in Year 2, based on state-wide standardized assessment outcomes

- ¹ Researchers conducted two mixed-effects regression analyses to test for selection bias among grades 4-6 teachers who signed up for PLI in 2016-17 using students' test scores from 2014-15 and 2015-16 for both ELA and Math. Results indicated that, on average, PLI teachers were quantitatively similar to their non-PLI peers prior to signing up for and being selected to participate in PLI.
- ² Prior performance was imputed with 2017 interim scores for those students missing a 2017 SBAC score to increase statistical power in the analytic models.

Figure 1.

ELA preliminary 2018 SBAC[†] scores for PLI and non-PLI students, by grade

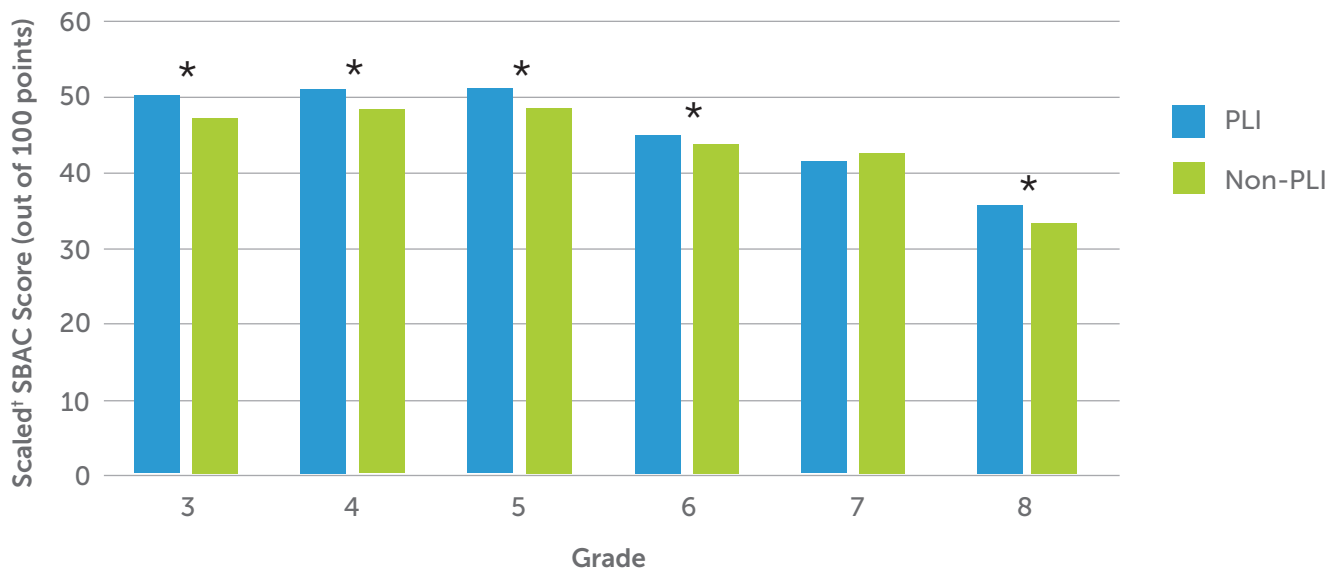


* Statistically significant relationship

† Preliminary SBAC data, rescaled to 100 points

Figure 2.

Math preliminary 2018 SBAC[†] scores for PLI and non-PLI students, by grade



* Statistically significant relationship

† Preliminary SBAC data, rescaled to 100 points

Evidence for PLI by Ethnicity

Enhancing learning outcomes for student groups that historically achieve at lower levels under conventional instructional approaches is an important goal of PLI.

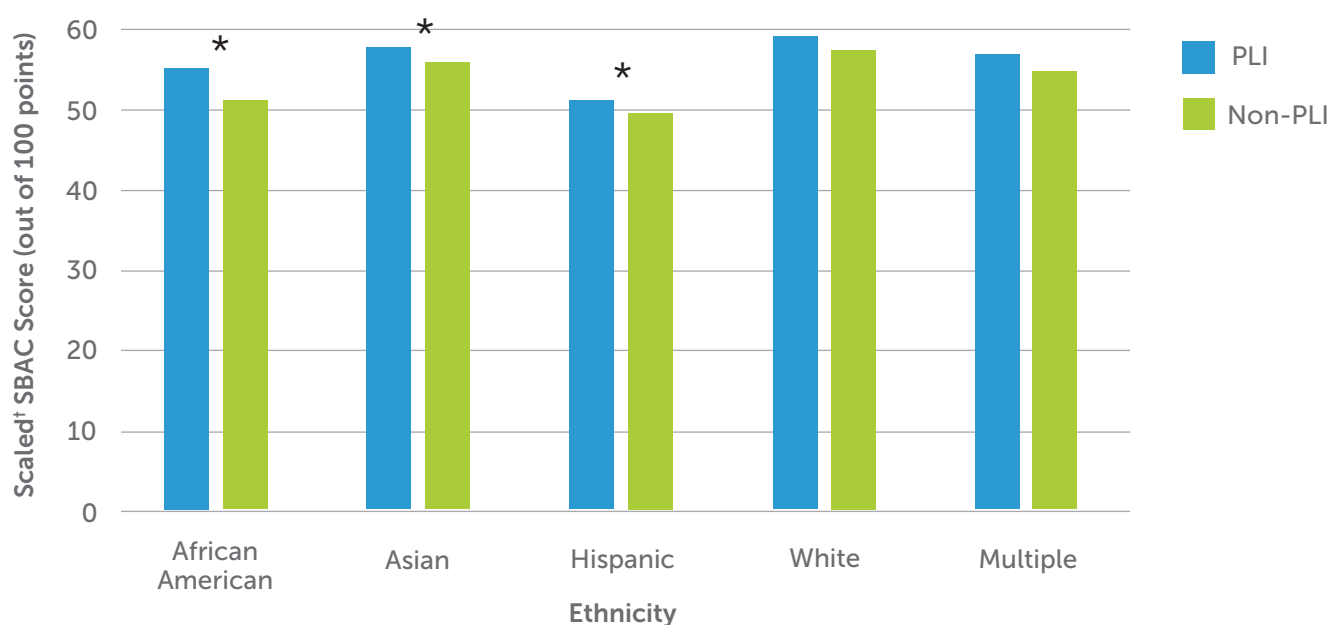
The Year 1 report addendum presented some encouraging data with respect to the PLI influence on Hispanic, African American, and low-income students' SBAC scores. We return to this issue using Year 2 SBAC assessment data. Figures 3 and 4 shows spring 2018 English language arts and mathematics assessment scores for elementary school students, by ethnicity. Again, the scores have been adjusted for previous standardized test scores, ethnicity, gender, ELL status, low income, homelessness, special education status, parent education, grade and attendance

rates as well as variation in school climate between schools. The PLI is associated with positive gains for African American and Hispanic students as well as for Asian students, and it did not have a negative impact on any ethnic group. These same patterns were also apparent in analyses for middle school grades.

Traditional achievement measures like the SBAC are important metrics but do not capture all of the competencies the PLI seeks to promote. Equally important, though harder to measure, are competencies such

Figure 3.

ELA spring 2018 SBAC scores for elementary school PLI and non-PLI students, by ethnicity

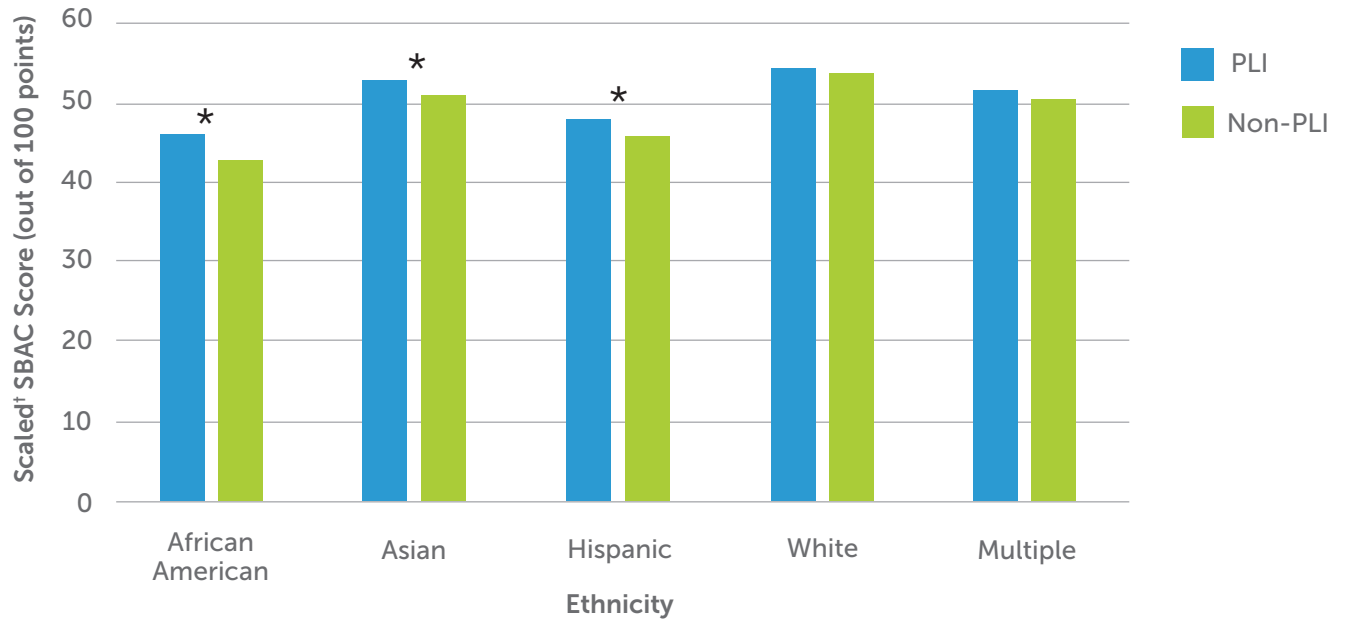


* Statistically significant relationship

† Preliminary SBAC data, rescaled to 100 points

Figure 4.

Math spring 2018 SBAC scores for elementary school PLI and non-PLI students, by ethnicity



* Statistically significant relationship

† Preliminary SBAC data, rescaled to 100 points

as the ability to collaborate and to take responsibility for one’s own learning. The data collected automatically as students use digital tools enabled analysts to examine objective evidence of student collaboration. As in Year 1’s analysis, PLI students are digitally collaborating significantly more than non-PLI students with the same level of technology access. Such digital collaboration also had a small but statistically significant association with higher ELA and mathematics scores on SBAC in Year 2.

Having such clear and consistent evidence of the PLI’s impact on student learning in its second year of implementation is a strong validation for the program. A great many

interventions in education systems—when implemented on a large scale—cannot demonstrate such outcomes as they expand. Many evaluations of interventions (e.g., The New Teacher Project, 2015) that focus on teacher professional development, for example, have shown no impact of such efforts on student learning. Thus, it is worth understanding in more depth the elements of the professional learning program provided by the PLI that are resulting in these outcomes.

What Elements of the PLI are Working?

Considerable research has been undertaken in the last decades to understand the elements of effective professional development (PD). A recent meta-analysis of studies (Darling-Hammond, Hyler, & Gardner, 2017) over the last three decades identified elements that effective professional development often includes:

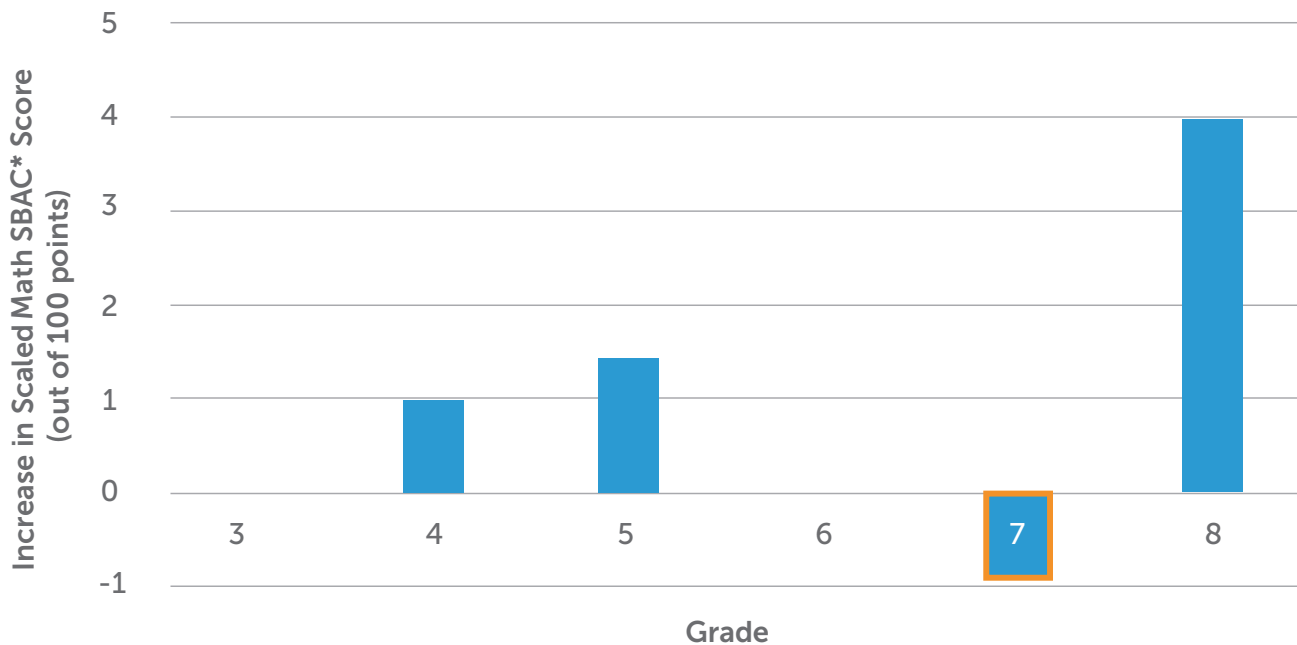
- **Content focused:** PD that focuses on teaching strategies associated with specific curriculum content supports teacher learning within teachers' classroom contexts. This element includes an intentional focus on discipline-specific curriculum development and pedagogies in areas such as mathematics, science, or literacy.
- **Incorporation of active learning:** Active learning engages teachers directly in designing and trying out teaching strategies, providing them an opportunity to engage in the same style of learning they are designing for their students. Such PD uses authentic artifacts, interactive activities, and other strategies to provide deeply embedded, highly contextualized professional learning. This approach moves away from traditional learning models and environments that are lecture based and have no direct connection to teachers' classrooms and students.
- **Supports for collaboration:** High-quality PD creates space for teachers to share ideas and collaborate in their learning, often in job-embedded contexts. By working collaboratively, teachers can create communities that positively change the culture and instruction of their entire grade level, department, school and/or district.
- **Use of models of effective practice:** Curricular models and modeling of instruction provide teachers with a clear vision of what best practices look like. Teachers may view models that include lesson plans, unit plans, sample student work, observations of peer teachers, and video or written cases of teaching.
- **Coaching and expert support:** Coaching and expert support involve the sharing of expertise about content and evidence-based practices, focused directly on teachers' individual needs.
- **Feedback and reflection:** High-quality professional learning frequently provides built-in time for teachers to think about, receive input on, and make changes to their practice by facilitating reflection and soliciting feedback. Feedback and reflection both help teachers to thoughtfully move toward the expert visions of practice.
- **Sustained duration:** Effective PD provides teachers with adequate time to learn, practice, implement, and reflect on new strategies that facilitate changes in their practice.

The professional learning opportunities provided to teachers in the PLI program offer most of these elements, and our analytics enables us to see that many of them are directly associated with gains in student learning.

Content focused. The PLI involves the adoption of subject-specific digital curriculum adoptions in mathematics and English language arts. The digital math curriculum

is provided by Houghton Mifflin Harcourt (HMH), and professional development for math teachers includes sessions on using these tools. In Figure 5 below, we see that frequency of use of HMH’s Go Math/Personal Math Trainer among PLI classes in grades 2-8 is associated with gains in SBAC scores in math in grades 4, 5 and 8, though it is negatively associated with outcomes in 7th grade where the number of teachers using the software was smaller than in other grades.³

Figure 5. Statistically significant effect of 1 month of HMH use on SBAC math scores for PLI students, by grade



* SBAC preliminary data; PLI n = 6,435

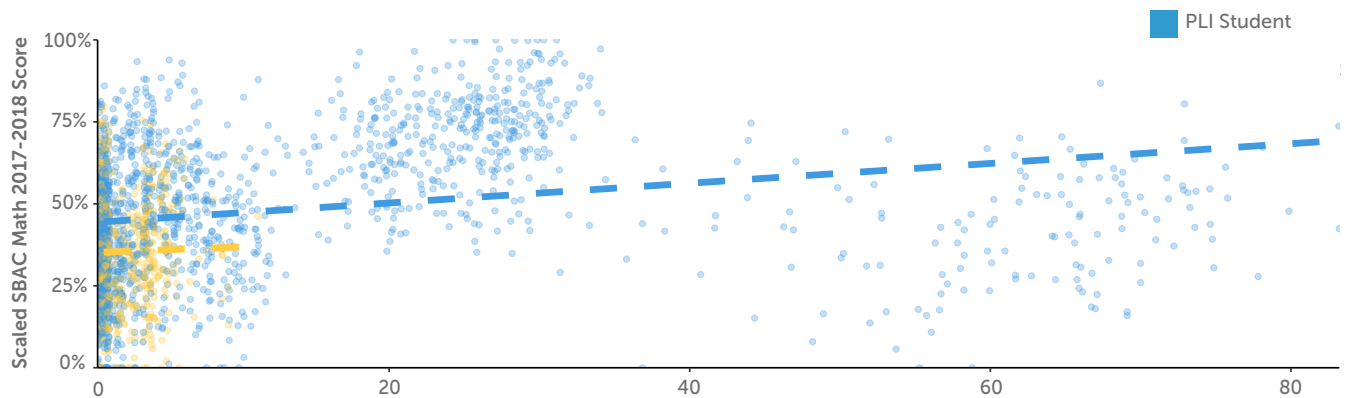
By going deeper into the HMH data, we have also been able to see which type of usage of the HMH tools leads to the strongest improvement in gains in math. Among the variety of features in HMH’s Personal Math Trainer (e.g. homework, tests and quizzes, daily interventions, and teacher-created assignments, etc.), the “teacher-created”

math assignments have the strongest association with higher achievement. In these assignments, teachers customize the math content in HMH to best meet their students’ needs. This insight enables the PLI to focus its HMH Personal Math Trainer professional learning in coming years specifically on this type of tool usage (see Figure 6).

³ The sample size for 7th grade was 674; 353 fewer than the next smallest sample.

Figure 6.

Impact of teacher-created HMH assignments on students' math SBAC scores

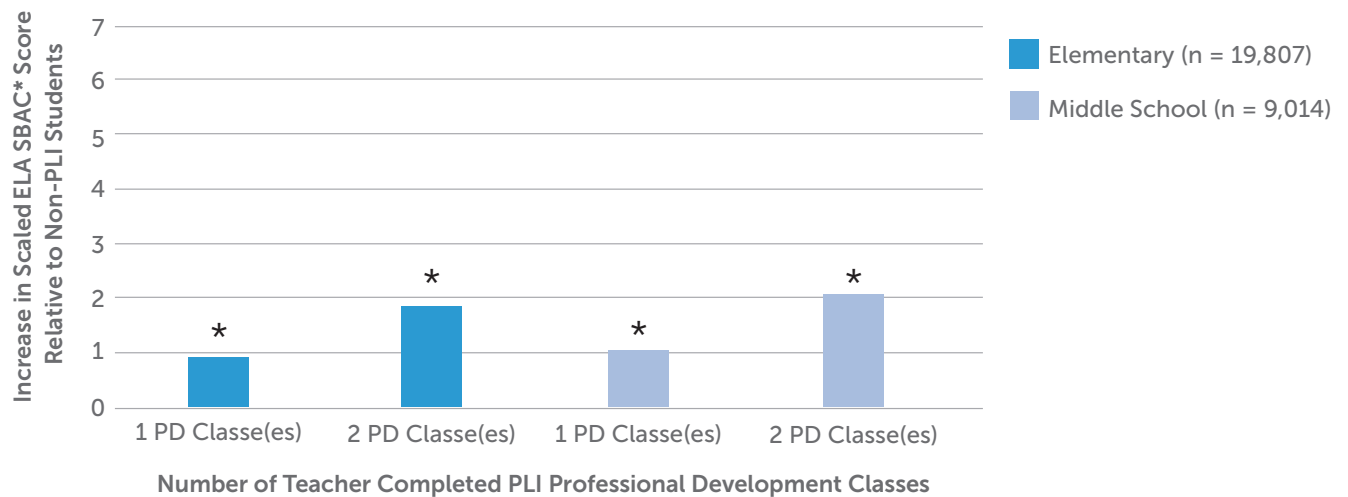


Incorporation of active learning. Since its inception, the face-to-face PLI professional learning courses have focused on teachers collaboratively developing learning tasks that model the pedagogical approach and which incorporate specific digital tools intended for these tasks. Titles of professional learning course directly reflect this focus. Course names include “Utilizing Digital Adoption Tools to Conduct Formative Assessments” and “Personalized Learning Initiative Camp:

Microsoft Teams.” Focused and active learning has resulted in a clear association between taking even one or two PLI professional learning courses and student learning outcomes. Figures 7 and 8 show that students whose teachers attended PLI professional development sessions gained more than students whose teachers did not, and that gains were larger for students of teachers who attended two sessions than for those whose teachers attended one session.

Figure 7.

Effects of number of PD classes taken by PLI teachers on students' ELA SBAC scores

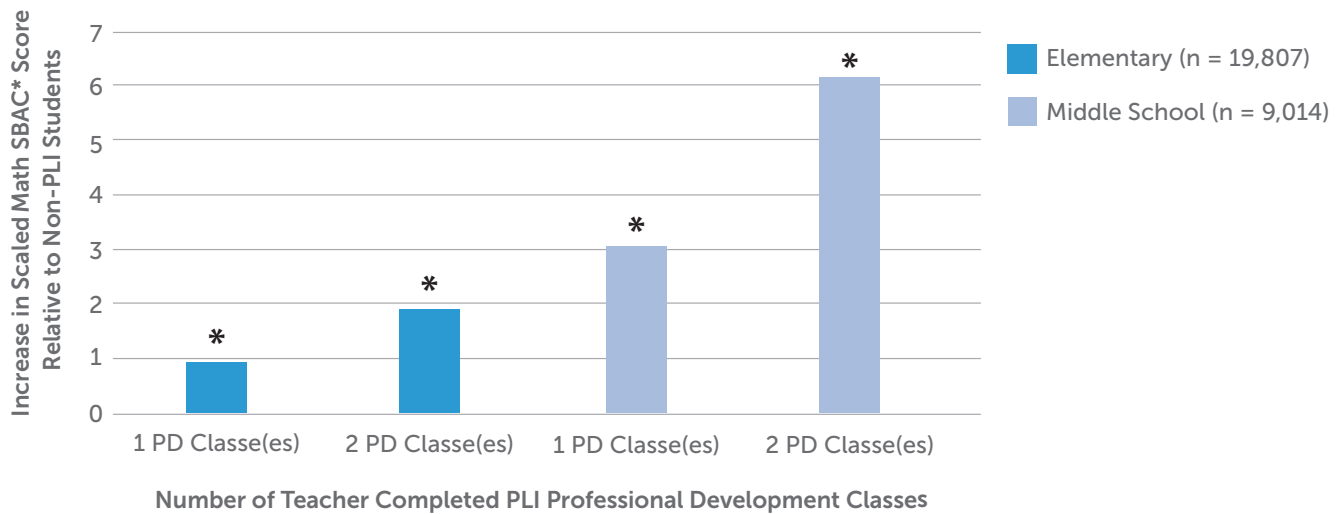


* Statistically significant relationship

† Preliminary SBAC data, rescaled to 100 points

Figure 8.

Effects of number of PD classes taken by PLI teachers on students' math SBAC scores



* Statistically significant relationship

† Preliminary SBAC data, rescaled to 100 points

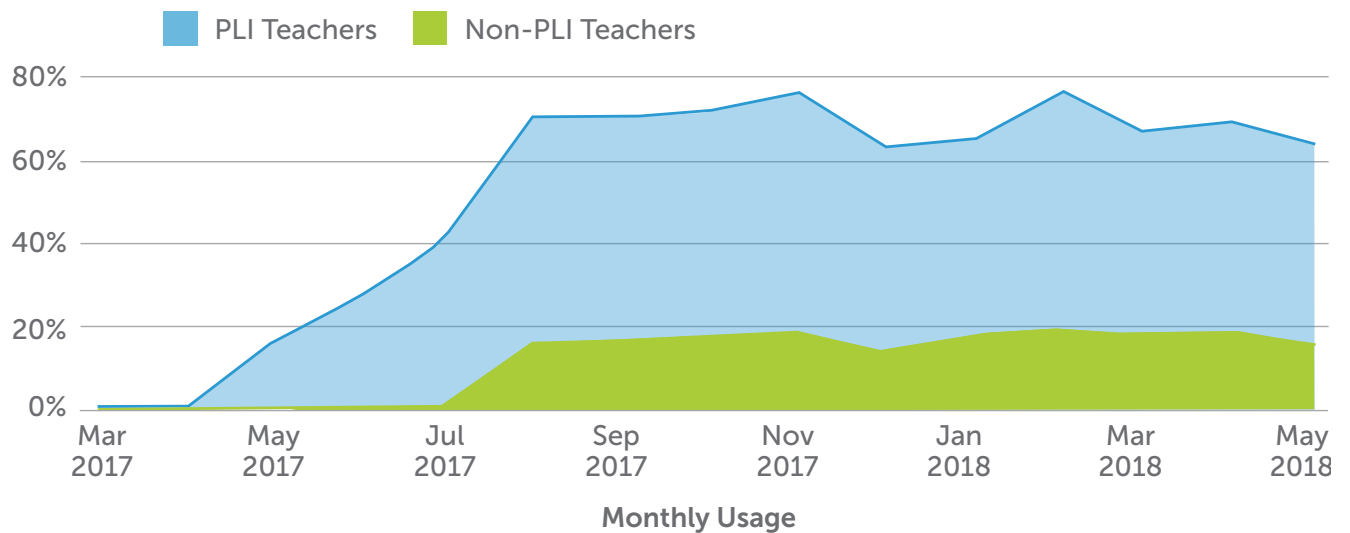
Supports for collaboration. Early designers of the PLI professional learning knew the importance of having teachers in the PLI participate in an ongoing community of practice. They leveraged the district’s existing practice of “Accountable Communities” (Fresno’s version of Professional Learning Communities) within and across schools to operationalize small communities of PLI teachers who could collaborate frequently. They also used a digital collaboration platform, Microsoft Teams, to provide a persistent storage location for all PLI training content used at the face-to-face courses, and an ongoing conversation stream among teachers in their subject and grade-specific accountable communities. As seen in Figure 9 on page 13, PLI teachers have indeed used the collaborative platform of Microsoft Teams frequently and consistently. More than two-thirds of PLI teachers used Teams daily in the 2017-18 school year.

Use of models of effective practice. When teachers participate in a PLI professional learning course, they do not experience the

usual technology professional development approach of introducing new digital tools and then showing teachers how to apply those tools in their classrooms. Rather, the conversation begins with a discussion of a teaching approach at the core of the PLI pedagogical model. For example, teachers may discuss the importance of student goal-setting and self-reflection, or how to use formative assessment to provide rapid feedback or to personalize instruction. Course leaders introduce digital tools as part of those conversations, asking teachers to use the Conversation pane in Microsoft Teams, for example, to describe how they ask students to set goals and self-reflect, or having teachers answer a set of questions in a Microsoft Form to conduct a group assessment of their confidence in using digital tools. This incorporation of the digital tools directly into the flow of professional learning activities gives participants an immediate sense of how to use such tools. The tools are not the focus of the discussion, but they are used to enable it. The conversation naturally flows into how teachers can use the tools in their

Figure 9.

Frequency of PLI teachers' conversations in Microsoft Teams 2017-2018



own teaching practice. The immediacy and ease of use of the new tools experienced by the teachers as they themselves are learning increases their confidence that they can use the tools with their students.

Coaching and expert support. After in-person PLI professional learning courses, PLI support staff shared their knowledge by becoming mentors to new PLI teachers in cohort 2. In addition, in Year 2 the PLI content managers and instructional coaches began collaborating with the PLI team to deepen and expand their repertoire of effective instructional practices. The PLI “Exemplar” teachers provided further support by allowing their classroom teaching to be videotaped so they could be viewed and discussed by peers for professional learning. The opportunity to view a PLI classroom in this way provides less experienced teachers with concrete examples of what the PLI can look like and opened a forum for meaningful exchange.

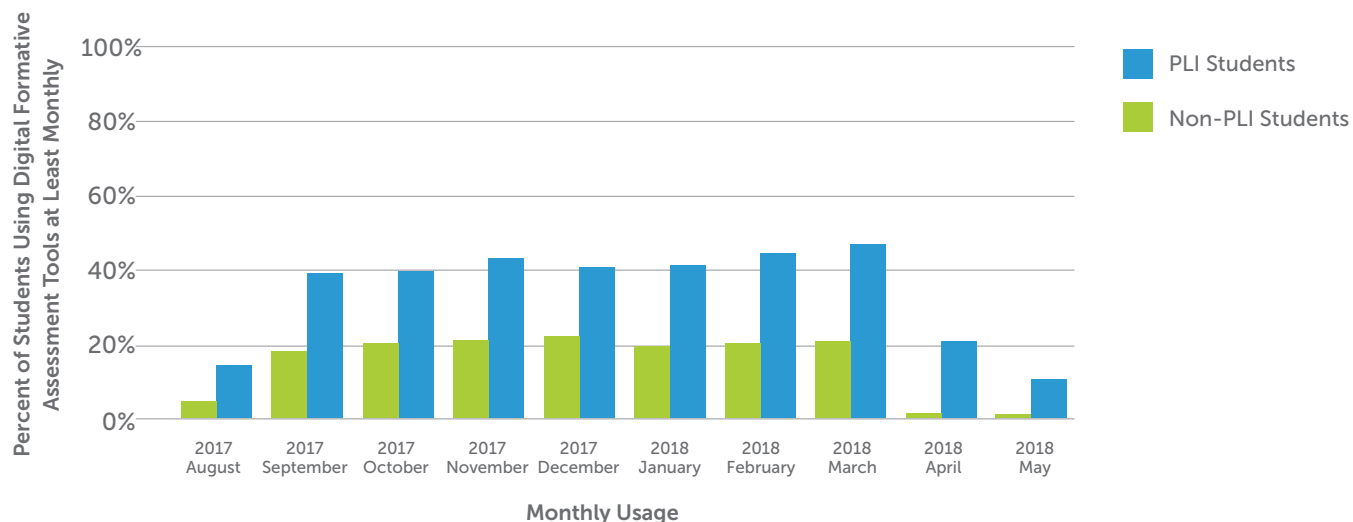
Feedback and reflection. The PLI employs a range of approaches for encouraging teachers to elicit and reflect on feedback about their instructional practice. For example, teachers

used the Teaching Channel—and more recently Microsoft Teams—to contribute to collaborative documents to share the “whys” of their instructional decisions. Taking the time to thoughtfully reflect in this way has resulted in more meaningful and insightful group discussions during PD sessions. The PLI also encourages teachers to use feedback and to reflect on their practice through the extensive use of digital formative assessment tools. The use of such tools was observed in site visits by Digital Promise researchers, who found PLI classrooms exhibiting:

- **Formative use of assessment tools and data.** As Figure 10 shows, PLI teachers are using learning system data to differentiate instruction for students with different competency profiles.
- **Faster, more frequent feedback for students.** PLI students get more consistent and rapid feedback when technology is used.
- **Student ownership/knowledge of their own learning.** Teachers reported that students take more responsibility for their own learning.

Figure 10.

Comparison of PLI and non-PLI students' use of Microsoft Forms for formative assessment



Our data analytics also shows a significantly higher usage of these formative assessment tools, such as Forms and Teams, among PLI students than among non-PLI students and provides evidence that practices promoted in PD are getting implemented in classrooms. Teachers using these tools have immediate information on whether their teaching approach is working, what areas students are struggling with, and whether specific students need specific supports. Using this data gives teachers rapid feedback on the effectiveness of their teaching practice and can lead to broader self-reflection on how one approaches teaching.

Sustained duration. PLI leaders design opportunities for teachers to participate in the PLI over the long term. Teachers who began in the first cohort are invited to continue to attend courses, to participate in both online and local school communities, and they continue to receive support as they implement digital tools in new ways in their classrooms. They are asked to share their

experiences—both the classroom wins and the challenges they've experienced—with teachers who are newer to the initiative.

One teacher who was in the very first cohort of PLI teachers expressed how this ongoing, sustained support from the PLI was what made this professional learning experience different from any other she has participated in: "It's the PLI leaders' commitment to keeping it ongoing. From day 1 they knew my name, and they respond to all my calls for help. They know exactly where I am in my development and help me take the next step, through all my tears. The ongoing nature of the community of practice is what has made the difference. I'm beginning year 3 of my involvement."

Teaching and Learning in PLI Classrooms

To provide deeper understanding of how PLI was being implemented at Fresno Unified, a team of Digital Promise researchers visited four elementary schools in spring 2018.⁴

The site visits aimed to gain insight into the culture of learning in classrooms participating in PLI. Investigations of interest included students' learning tasks, providing students with feedback, collaborative learning, activities with cultural or real-world relevance, and involvement in creativity or knowledge construction. One of the findings from those observations was that **students were actively engaging with rigorous, standards-aligned tasks**, including extensive alignment with grade-level standards. PLI teachers also reported their instruction has become more student-centered, which the above data on teacher-created assignments confirms.

A major element of the PLI teacher professional learning is using digital tools that support the pedagogical model in classrooms and learning tasks. Teachers often state their motivation to begin using digital tools as "to engage my students" or "to ensure my students are digitally competent." While those are important ends, the PLI emphasizes using digital tools more intentionally for specific purposes that are designed to achieve specific learning outcomes. Many education systems provide digital tools to their teachers and students, but those tools are not always used in classrooms, implemented with intentional pedagogical purposes, or measured in relation to learning outcomes. Through our PLI analytics

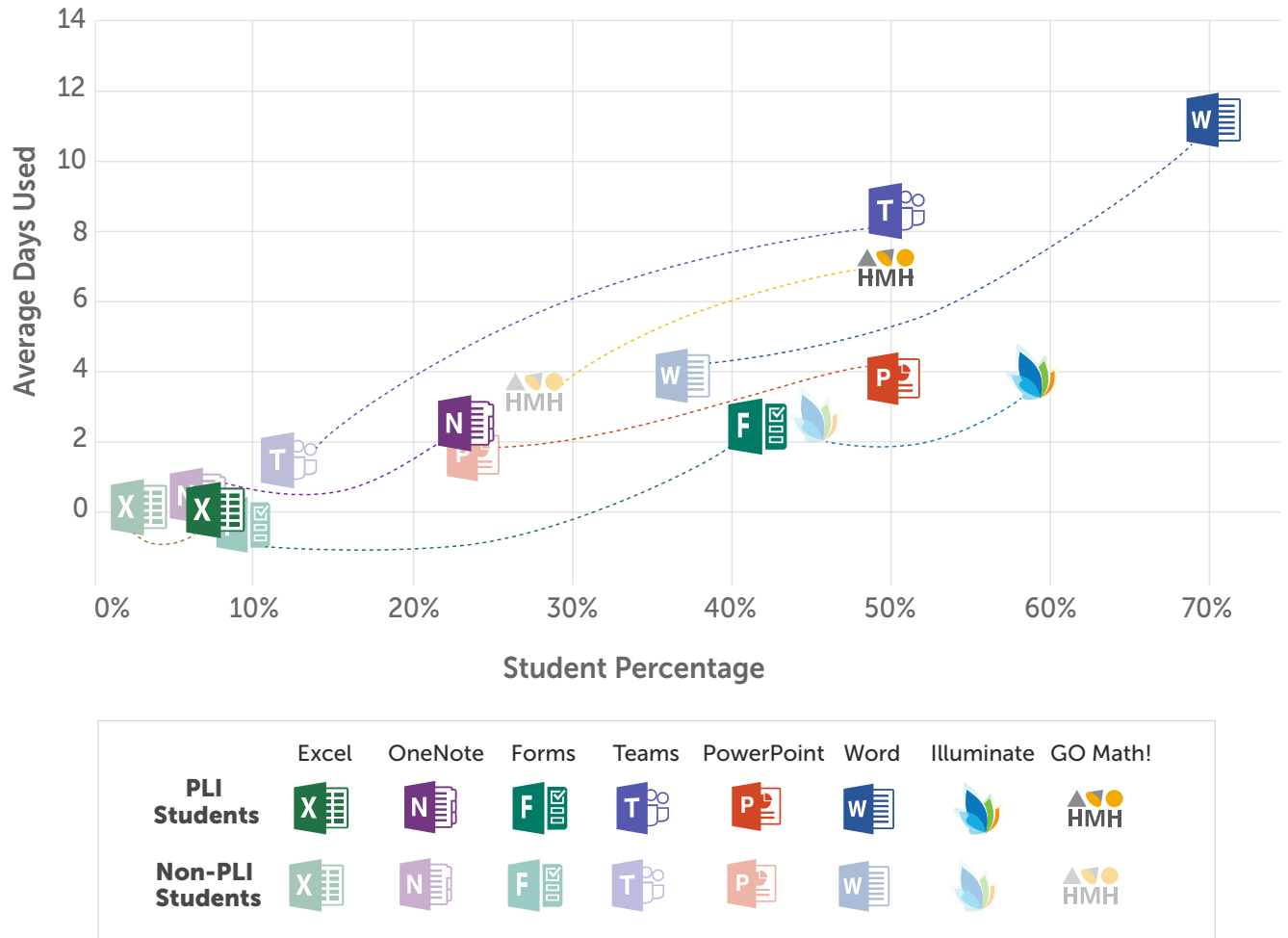
partnership, we can examine these aspects of digital tools adoption and use in Fresno.

First, we can see in Figure 11 below that PLI teachers' students are in fact using digital tools aligned with the specific intentions of the PLI implementation. Those intentional uses include using Microsoft Teams to digitize the assignment workflow, improve student collaboration and personalize instruction; using Houghton Mifflin Harcourt's Personal Math Trainer within Go Math; using formative assessment tools such as Illuminate and Microsoft Forms; and using the collaboration features of Microsoft Word and PowerPoint. Figure 11 shows the percent of non-PLI students (faded versions of icons) and of PLI students (darker icons) using these tools along the bottom or x-axis, and the average number of school days that students used them along the left or y-axis. As the figure shows, more PLI students are using the digital tools, and using them more frequently, than students who have the same level of technology access but whose teachers are not in the PLI. Students' use of these applications was confirmed through direct observations of PLI classrooms by researchers from Digital Promise, *who reported increased technology integration by both teachers and students.*

⁴ Of these visits, two were PLI Partner schools and two were non-Partner schools. In each of the four schools, researchers sought to observe classrooms at the 4-6th grade levels that were engaged in PLI activities, as well as to interview PLI teachers and hold a focus group with students. Altogether, researchers conducted 11 classroom observations, 9 teacher interviews, and 4 student focus groups (one per school). Researchers summarized the information gleaned from each visit in a standard debriefing form.

Figure 11.

Percentage of tech tool usage by PLI and non-PLI students

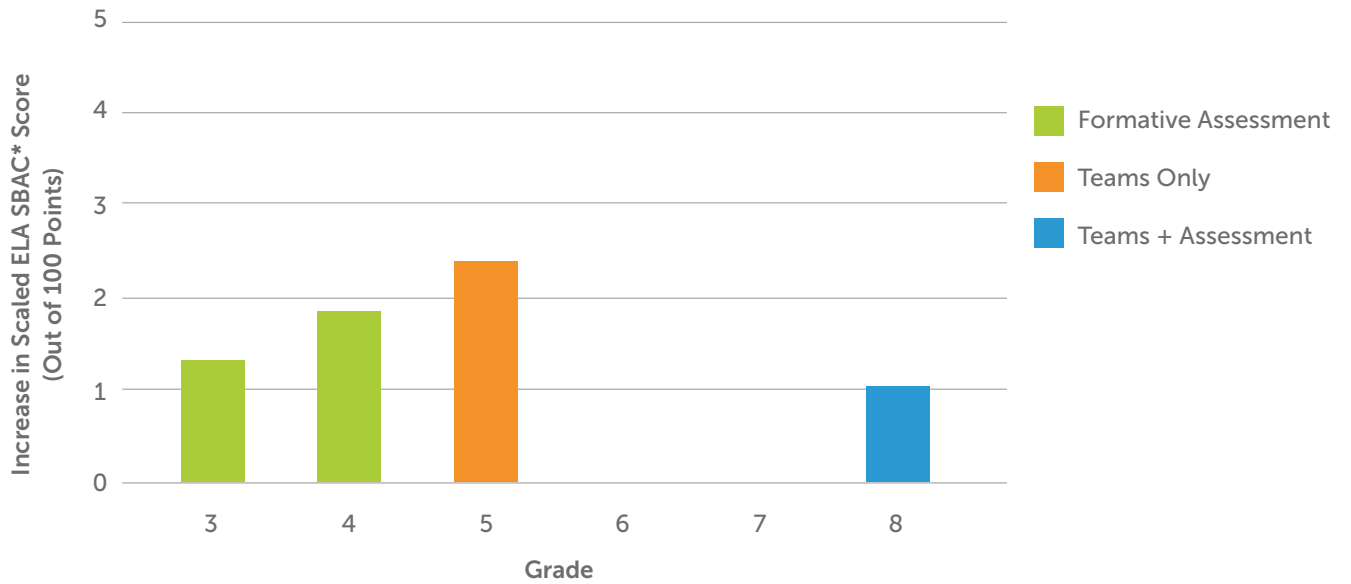


The positive impact of students' use of technology is further evidenced by their test scores. Figure 12, below, shows the relationship between PLI students who used these tools for a one-month period and their outcome scores on SBAC math and English language arts tests. These charts shows

the difference in SBAC scores for those PLI students who did and did not use each digital tool for a month within different grades and subject areas. (Data are shown only for the digital tool with the strongest association with SBAC scores for that grade and subject.)

Figure 12.

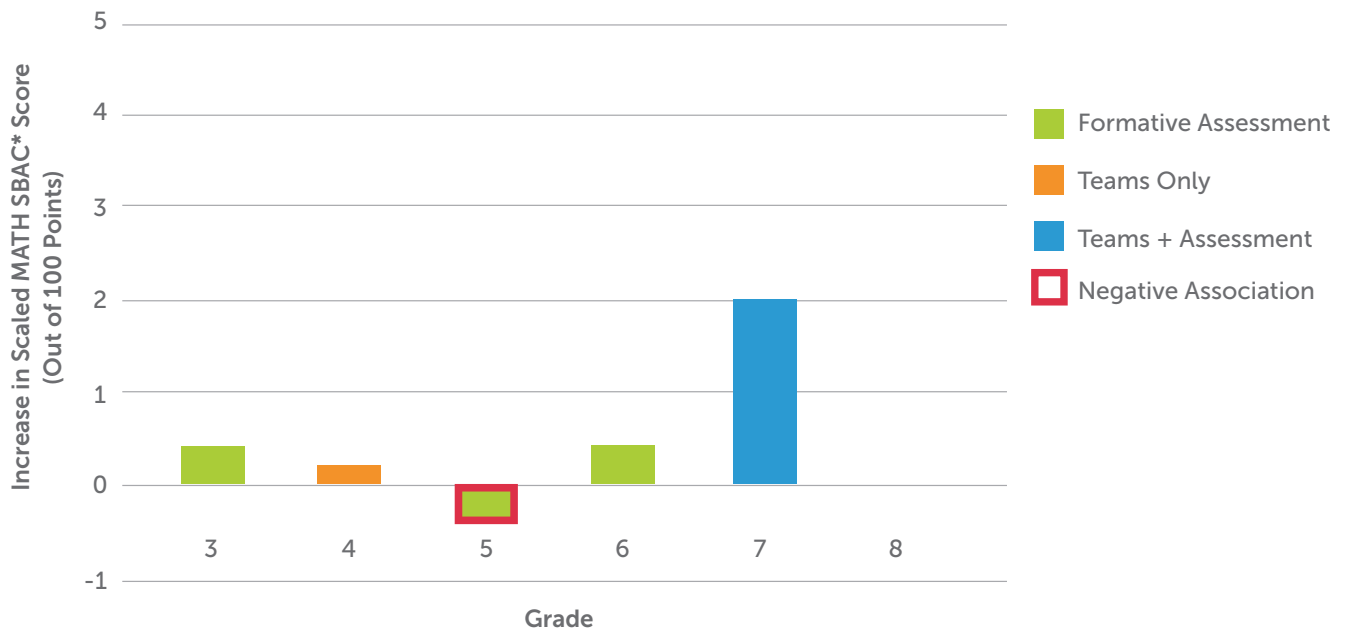
Statistically significant effect of 1 month of top Microsoft Edu app on PLI students' SBAC ELA scores, by grade



* SBAC preliminary data; PLI n = 7,487

Figure 13.

Statistically significant effect of 1 month of top Microsoft Edu app on PLI students' SBAC math scores, by grade



* SBAC preliminary data; PLI n = 6,428

Positive Outlier Teachers

Analyses of both SBAC scores and district interim assessments over a two-year period suggest that students with a PLI teacher are making larger achievement gains than they would have otherwise. To further improve achievement and do so reliably at every grade level and for every school, we need to deepen our understanding of the specific practices responsible for the gains. One approach is to examine the average student learning outcome measure for each teacher after controlling for students' level of achievement the prior year. This analysis was conducted for PLI exemplar teachers, PLI teachers in partner schools, PLI teachers in non-partner schools, and non-PLI Teachers.

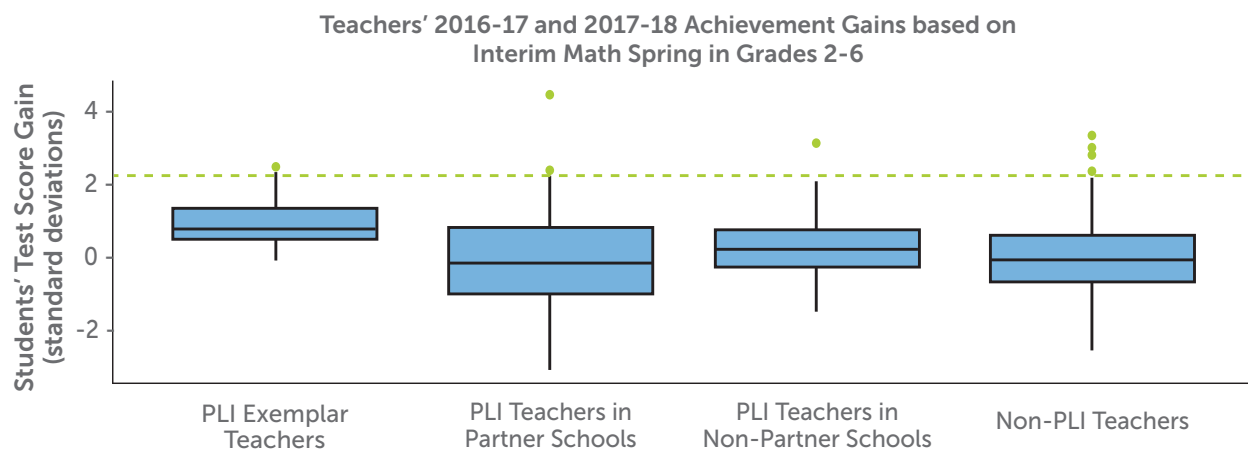
The chart in Figure 14 shows the average deviation from the mean mathematics gain score for these teacher groupings in grades 2-6. The horizontal line in each box shows the median gain for each teacher group, and the boxes represent the range for 50% of teachers in that group (the 25% of teachers in the quartile above the median and the 25% in the quartile below). The vertical lines denote the range for the top and bottom teacher quartiles, excluding what are known as "outliers." Outliers are extreme data points that are well outside

the first and third quartile of other values, either very low or very high. The green dots above the vertical dotted line represent individual teachers whose students "beat the odds" by gaining higher student achievement than students in other classes. (Note that there was at least one outlier teacher in every group.) Next year, we hope to examine in detail the practices of these "positive outlier" teachers to derive insights to inform future professional learning activities.

The box plots in Figure 14 suggest that achievement gains were highest for PLI Exemplar teachers, followed by PLI teachers in non-partner schools. Gains for students of teachers in PLI Partner schools were not higher than those of non-PLI teachers districtwide. Only a minority of teachers in these Partner schools were PLI teachers, and Exemplar teachers in these Partner schools were included in the "Exemplar" group (thus lowering the range of non-Exemplar teachers). Given this finding, deeper engagement with and supports for PLI Partner schools will be explored in 2018-19. One factor we know from our data is that in Year 2, Partner school teachers experienced fewer PD opportunities led by PLI staff than other PLI teachers last year, so PD will be expanded to Partner schools in Year 3.

Figure 14.

Teachers' 2016-17 and 2017-18 achievement gains based on interim math spring SBAC in grades 2-6



The PLI Partnership – Enabling Analytics for Improvement

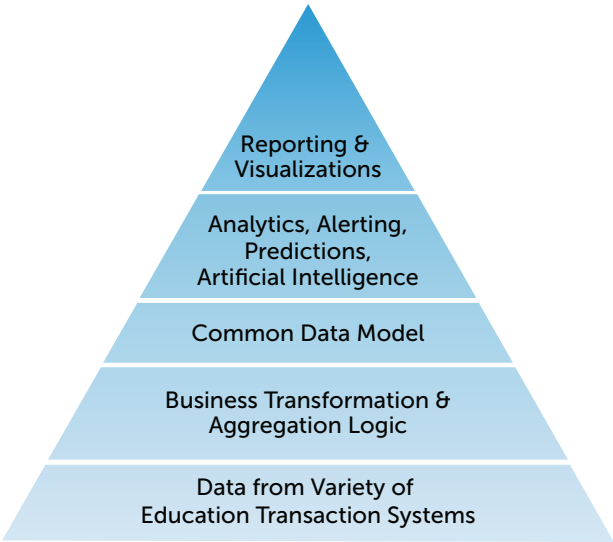
Why the partnership works. In addition to its influences on teacher professional learning, classroom practice, and student achievement, Fresno’s PLI is valuable as an example of how school districts, technology providers, and external researchers can work together in multi-stakeholder partnerships to address the challenges that school systems face. Three aspects of the collaboration among Fresno Unified School District, Microsoft Education, Digital Promise and Houghton Mifflin Harcourt are particularly noteworthy.

First, all four organizations **share a common goal**—to enhance deeper learning outcomes for all of Fresno’s students by providing teachers and schools with a well-defined and innovative pedagogical model, high impact professional learning opportunities, technology tools aligned to these approaches, and learning from improvement analytics. Our mutual commitment is demonstrated through our shared focus and work on defining and developing the kind of learning that matters for students, teachers’ capacity and digital tools aligned to that learning, and the imperative for equity in implementation and impact.

Second, the partnership has been **enabled by an explicit approach to data governance, data science and using learning analytics for improvement**. The technical, data security and privacy compliance elements of setting up an analytics partnership of this scale is highly complex. All partners collaborated extensively in developing our governance approaches that serve as the foundation for the analytics work. Our first step was to develop a legal agreement defining the interests and goals, data management process and intellectual

property terms for the analytics project, ensuring that the work met the highest standards of student data privacy protections.

Data Governance: No personally identifiable information is shared between the partners as part of the analytics process. All data is de-identified by Fresno Unified before going into the Microsoft Azure SQL database, a secure data repository. This database is hosted on Fresno’s own Azure subscription, and all data



stays within the 'boundaries' of this private cloud environment. The Microsoft Education team developed an Education common data model for analytics that enables the variety of data to be joined and analyzed across the many different data sources identified for the project, including student information system data (class rosters, student and teacher demographics, attendance, behavior, GPA); assessment data (including interim assessments and SBAC); survey data (including school climate and social emotional surveys); technology usage data (including Microsoft Teams, Forms, OneNote, and other O365 app data; device login data; Houghton Mifflin Harcourt Personal Math Trainer data; and Illuminate data) and PLI-specific data (teachers and students participating, professional learning activities). A virtual machine was also set up within Fresno's secure Azure environment to manage the identity and network access, and to provide data science tools. Finally, PowerBI is joined with the data model and visualized for district leaders through PowerBI reports and visualizations.

Data Science: Microsoft, Digital Promise and Houghton Mifflin Harcourt analyst teams access the data, conduct data exploration and run analytics on the de-identified data through the virtual machine, with identity and network access controlled by Fresno's IT team. Experienced education researchers from Digital Promise guide the analytics to ensure high standards of research are implemented. All learning outcome data have controls applied for: ethnicity, gender, ELL status, low income, homelessness, special education, parent education, attendance percent, and prior scores as well as grade and variation among schools' climate.

Learning Analytics for Improvement: From the beginning, the focus of the analytics work has been to use an "improvement science" approach, rather than seeing the

work as evaluation or research (Bryk et al., 2015). This means that we seek to use analytics primarily to determine what in the PLI intervention is working and what is not, to use that as feedback to improve the intervention, and to build further measures and analysis of the most effective practices. Digital Promise researchers have provided detail on the processes for establishing and implementing this kind of collaborative, data-intensive improvement effort in a recent book (see Krumm, Means, & Bienkowski, 2018). Data-intensive research "can be useful for inspiring ideas for change. But these data products are merely a means to that end; they are not the same thing as changing what and how teachers teach and students learn" (p. 161). We have found that teams from every partner organization have important knowledge and insights to contribute, especially on what data to examine and how to interpret data patterns. We do not believe that any of the partners by themselves could accomplish what we have done together.

Finally, **the third aspect of our partnership is Trust**. The shared values and approaches described above foster mutual trust, one of the most important elements for a successful partnership (Bryk & Schneider, 2004). Only with a high level of trust can district teachers and leaders, technology partners, and researchers work side-by-side and willingly share their respective uncertainties so that everyone can learn. Trust is what fundamentally enables the multi-stakeholder approach to learn collaboratively. We have found that this trust is built over time and is just as much about personal relationships, accountability for specific team responsibilities, and respect and appreciation of each partner's expertise as it is about the data.

Conclusion and Future Directions

For those reading this paper, the value of Fresno's PLI story is perhaps not that personalized learning or well-designed professional learning experiences are having a clear impact on learning outcomes. The success of the initiative in its first two years is validating, but the value of the story lies in the insights about its implementation.

Which elements of its teacher professional learning, digital tools, analytics and its partnership are driving progress? Other systems embarking on similar initiatives can learn from these implementation lessons. Every system seeking to drive improvement will pull together elements of their own implementation based on the unique contextual factors of their schools and systems. As Fresno's CIO Kurt Madden has said, "The goal of this work isn't just to capture what the PLI is at Fresno Unified, but to be used as a tool to inspire other districts and to show what a true public/private partnership looks like."

We are far from done in the work of our partnership. While the first two years of the PLI has shown clear evidence of progress, we believe that the PLI's impact on student learning can and should be deepened and broadened. **Our goals for the coming years** of the partnership include:

Deepening the Improvement:

1. Develop more detailed understanding of high-impact teaching practices and learning activities being used in the most successful PLI classrooms, and co-construct with teachers the best ways of measuring and expanding those practices.
2. Create a process for identifying exemplary learning activities and sharing them within and across schools via the collaboration platform.

3. Experiment with enhancing standards-based content with real-world activities that draw on students' interests and cultures.

Broadening the Impact:

4. Investigate and develop more targeted PLI approaches relevant for the increased maturity of high school students, with initial focus on improving high school math.
5. As the PLI expands to 25 "partner site" schools in 2018-19, explore how work at the whole-school level can be improved through expanded professional learning opportunities, specific types of leadership involvement, and using learning analytics as part of the school improvement work. Fresno Unified is partnering with Education Elements for the design and implementation of this work in ways that align to the district's instructional foundations while fitting the local school context.

Finally, we would like to encourage other schools and systems working on personalized learning and improvement approaches to learn from and with us. For example, we have learned the importance of designing the PLI as a coherent ecosystem that includes standards, curriculum, assessments, and teacher PD. Even with a holistic design approach, we have learned that it is challenging to spread the PLI when partner schools have only a few participating teachers and receive less district-provided PD. As we have described here, an essential part of the success of the PLI in Fresno has been our multi-stakeholder partnership between Fresno Unified, Microsoft Education, Digital Promise, and Houghton Mifflin Harcourt. We encourage other education leaders to embark on such partnerships which can expand the resources, expertise, and gravitas of your own initiatives in ways that deepen all stakeholders' commitment to success.

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