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PACE Programming the Acceleration of Computing Education

Implementation Guidance from PACE Practitioners and Students

The "Why"– The Benefits of Investing in CS through PACE

Despite the critical importance of developing computer science (CS) skills and knowledge for all students, many schools and districts lack the capacity, resources, and strategic planning to provide a robust CS learning program. By participating in PACE, a set of six districts in Massachusetts, the majority rural and/or high-needs districts, identified CS as a crucial area of focus for their students. To that end, they engaged in multiple years of systems-level change activities to install a new infrastructure so that all students had access to rigorous high-quality CS instruction.

The Difference with PACE: Teachers, Administrators, and Students in Participating Districts Weigh In

- *"Students need to see that they can do CS, and that it isn't really that hard. We can see a transformation in students in just three weeks, where they go from saying they can't do it to being the lead programmer for their group." —PACE Teacher*
- *"At the high school, we've moved from having no classes three years ago to currently six sections of CS. We now see our students coming in with skills and understanding of CS that wasn't present before, and that makes a difference in what I can teach and what we can do." —PACE High School CS Teacher*
- *"Kids see the results, and it helps them persevere: it's really exciting time for kids. At first they're kind of really nervous, and they're, like, 'I'm never going to learn this.' But then, when we're halfway through the unit, and they're making things. Now is the final week of the quarter so they're actually making games that work and the codes running, and students are, like, 'Wow! Look at what I did!', and just to hear the enthusiasm and excitement in their voice." —PACE Teacher*
- *"I thought it was just like I'm stuck on a computer, and I get told what to do. But then when I got to do a project, and I saw that it was totally my idea, I got to use whatever programming I wanted I could do, whatever my mind was set to, that was very good..." —PACE Student*
- *"I started to get more into editing things and a little bit more into coding, so I started to realize it's more applicable to real life stuff nowadays." —PACE Student*

Key Levers for Leading District-Level Systems Change. In 2025, members of the PACE research and evaluation team conducted a set of interviews with school staff, leadership, and students of these six districts to gather guidance for other districts that seek to strengthen their CS pathway. Those interviews highlighted that the work to improve begins with establishing a shared vision for CS education and supporting students and staff to see that CS can thrive in settings where it has not been before. Following are a collection of statements from the interviews that make the case for why districts should invest in CS as part of their overall efforts to serve their students and families.

The PACE initiative combined a set of strategies to guide districts toward building that vision and a supportive infrastructure for CS. Interviews with students, teachers, and administrators in districts involved in PACE were conducted in 2025 to identify the key levers that contribute to sustainable

district change, and actionable steps and cautions that can guide planning. These are provided here as *Key Levers*.

Key Lever 1: Leadership support is crucial, but ***district stakeholder councils make the work sustainable and scalable.*** PACE included the creation of District Stakeholder Councils (DSCs), a group of teachers, administrators, counselors, and community members who met at least four times a year to oversee the implementation of a robust CS program. The DSC helped maintain momentum during turnovers in the central offices of multiple districts.

Guidance from Practitioners

- It was helpful to have an external facilitator from PACE who served to keep the work moving forward and brought the group together. The facilitator took responsibility for arranging schedules, setting an agenda, and leading the discussion.
- Modest stipends provided through PACE to DSC participants helped some to overcome their hesitancy to take on leadership roles around CS and also indicated that the DSC was a meaningful commitment that was important.
- It was important for the DSC to have tangible products and artifacts that marked its work. For example, the vision statement provided a clear purpose for what the group was going to do together.
- The DSC meetings provided a space to coordinate CS activities and make CS programming consistent across grades and courses.

Key Lever 2: ***Establish CS as a school and district priority on the course schedule.*** Districts must be willing to create urgency and establish CS as a priority by getting it on the master schedule for all students. One PACE leader emphasized the importance of ensuring that each student is guaranteed exposure to CS:

> [You need to] *build in consistent exposure for all students, because they don't know what they don't know. Get CS in front of them. We wouldn't have done this step without PACE but* [adding CS to each student's schedule] *is a very good way to get started as a district- and systems-strategy.*

Guidance from Practitioners

- Many districts faced logistical challenges to get CS on the schedule for all students, but in the end, all were successful. To create urgency, an important strategy was to highlight how CS aligns with state and local policies, such as the Massachusetts CS standards, and district strategic plans.
- Even if your goal is to improve CS across K–12, it's strategic to start with a focus on the middle grades, which can then be tied into the other grade spans. Also, practitioners noted that it's easier to get girls interested in CS in middle school than in high school.
- Teachers and administrators have a role to play in communicating to students that CS is a priority. Practitioners recommended taking the time to "sell" CS courses to students and to make course titles relevant and engaging as a way to increase enrollment—especially enrollment by girls specifically.

Key Lever 3: Make sure to have the building blocks needed to create a CS infrastructure— ***collaboration, coordination, and materials.*** Creating a districtwide infrastructure for CS requires time, which needs to be used purposefully to create systemic levers. For example, librarians in one district had led units on programming through Scratch, but it wasn't until they joined PACE and worked with a liaison that it was done systematically and made available to all students to the same extent.

Guidance from Practitioners

- Think critically about the materials used in your CS curriculum. PACE participants found it valuable to have colleagues, either in their school, district, or community of practice, with whom they could review materials. These networks were especially valuable because PACE teachers noted that they benefited from collaborating with their colleagues to apply the new curricular materials in their classes.
- Coordination across grades and elementary, middle school, and high school grade spans is necessary. In PACE, the DSC meetings provided a dedicated time and process for these levels of coordination.
- Similarly, DSC meetings and PACE community events provided PACE participants with valuable opportunities to learn collaboratively. These opportunities were not available prior to PACE when many CS teachers worked in isolation from others in CS.

Key Lever 4: Take steps to ***build staff confidence in order to get buy-in to CS.*** PACE participants said that districts should expect to have to build CS capacity among staff, especially with staff in rural districts, and that staff, like students, may not see themselves as CS experts and leaders. One PACE district administrator underscored the need to build trust among staff:

> *From the administrative perspective, it's about building relationships with teachers so that they're comfortable taking these academic risks—bringing in new curriculums, and sometimes it doesn't go well, or sometimes certain robotics aren't the right fit, and kids get crazy sometimes when they have these things in their hands. So, creating that atmosphere where there's an understanding that it's okay to take these academic risks, let's try it together. If you're a partner with these teachers, you're in it with them. You're willing to take these risks with them. So just developing those relationships is key.*

Guidance from Practitioners

- Ensure that your plan includes time for staff to get used to the CS materials and curriculum. Many staff were doubtful or uncomfortable when PACE began (even if they had a CS certification). However, over time and with support, they found their comfort level with their roles in supporting CS instruction grew.
- Access to professional development (PD) was a major help to CS teachers. Multiple participants noted that the Code.org PD was a good match for them and provided a good foundation and entry into CS instruction.
- The use of stipends for participation in PD and the DSC helped several teachers overcome their initial hesitancy and served as motivation for entering into the work.

- Instruction in CS is different than instruction in other courses, as the teacher's role is more frequently facilitating rather than leading direct instruction. This was an adjustment for some teachers, and they needed time to adapt.

Key Lever 5: Don't just analyze data—look for warts. ***To create a stronger CS pathway, you need to have good data and be willing to look at it critically.*** In one PACE district, an initial analysis of student enrollment in CS courses at the department level found no discrepancies. However, a closer examination revealed large gender differences at the class level, with many more boys than girls in a CS Advanced Placement class, and many more girls than boys in a digital literacy course. Through discussions facilitated by the PACE liaison, the DSC identified increasing the representation of girls in the AP class as an area of focus in their CS planning.

Guidance from Practitioners

- Inequitable participation and achievement in CS can be hidden in some datasets. For example, practitioners noted that gender discrepancies were only apparent when looking at the most rigorous CS courses and were not apparent when looking at CS enrollment across all courses.
- It's important to distinguish between digital literacy and CS courses when looking at enrollment, as CS courses tended to focus more squarely on CS skills and knowledge and had gender discrepancies in enrollment.

Middle School Student Perspectives on Computer Science Teaching and Learning in PACE. PACE researchers conducted a series of focus groups with middle school students at PACE schools. Here, we present themes from the focus groups to highlight student perspectives of their CS courses, including:

- Aspects of CS courses that helped them learn or made it harder for them to learn
- Advice to school leaders and teachers for creating engaging CS courses
- Factors that influenced their decisions for continuing with CS courses in high school

What students viewed as key aspects of CS instruction that contributed to their learning.

- Students appreciated that their CS courses allowed them to learn from their mistakes by giving them opportunities to revise and improve their work. They contrasted this with other classes where mistakes often carry penalties, highlighting CS as a safe environment for experimentation and exploration.
    - *"I can make something, and then I can see, I can say, that didn't work, and then I can go back, and I can fix it again and again until it's perfection…"*

- Students appreciated how CS class promoted problem-solving and critical thinking through open-ended challenges.
    - *"We started from nothing and ended up making a project."*
    - *"I liked having a problem to solve and the freedom to figure it out."*

- However, students also noted that some CS classes had a lot of structure and limited opportunities for flexibility, and this had a negative impact on their interest in the class.

  - *"It didn't really feel like I was making something. It felt like I was filling in a worksheet."*
  - *"Felt like I wasn't doing it on my own…it was guided."*
  - *"We didn't really make a website… it was just Code.org, so it didn't feel real."*

- Students valued the opportunity to do work with student partners and to share and develop ideas together in their CS classes. This collaboration helped them approach problems from multiple angles.
  - *"You get to work with partners, so that's like fun."*
  - "*Definitely the groups* [is something good about CS class]. *I feel like the group should play a big role on it."*

- CS stood out as more engaging than other classes because it features more hands-on and real-world applications than other subjects, such as building, designing, coding, and using physical tools (e.g., robots).
  - *"I think, in 6th grade you just did basic coding, but, in 7th and 8th, we got to do more of the projects and everything which make* [it better]*."*
  - *"We started to realize it's more applicable to real life stuff."*

Insight from students on their decision-making for continuing on a CS pathway.

- Students' decisions about continuing with CS in high schools weren't only based on their interest in CS. It also reflects their interest in taking other, newer, and engaging electives that were not offered previously. Even if they enjoy and see value in CS courses, they may opt for another class that reflects a different interest.
  - *"I feel like* [computer science] *is interesting, and I wouldn't mind taking a class like learning more about it, but at the same time, I'm open to more new things."*
  - *"Wouldn't mind doing it again, but I'd rather do more new things."*
  - *"I'm kind of interested more in the building aspect and like plumbing and putting things together to solve problems."*

- Students evaluated their interest in CS through their perception of its relevance to their career aspirations. However, students will likely need support in assessing if the connection to CS exists. They may miss its relevance to their long-term goals and see CS as only about "coding" or "making web pages" and not as a broader discipline that contributes to many fields.
  - *I want to be a psychologist…CS and psychology don't really go together."*
  - *"I want to go into cosmetology…it has nothing to do with coding."*
  - *"Maybe a pilot…doesn't seem like it connects to CS."*
  - *"Not sure if I'd need* [CS] *in medicine."*

Advice gleaned from students for teachers and school leaders creating a CS pathway.

- Students value engaging in active project-based work over doing repetitive exercises. They want to apply their learning in meaningful and creative ways.

  - *"I liked having a problem to solve and the freedom to figure it out."*
  - *"I prefer physical projects where you can build stuff and code with it..."*

- Students see opportunities for teachers to provide them with the chance to explore, take risks, and learn from mistakes.
  - *"Give students freedom to work on what interests them."*
  - *"Include students' personal interests in the projects."*
  - *"Poll the students to see what they think sounds fun and try to teach those things throughout."*

- A CS curriculum that includes a range of CS topics keeps students interested and supports different passions—beyond just games or coding drills.
  - *"Make it diverse—not just web design all year, but include game making."*
  - *"Include web design, and graphic art, too."*

- Peer interaction and working in teams matter—social dynamics can enhance the classroom experience.
  - *"We can bounce ideas off each other, and then we can come up with a big idea. And that's unlike our other classes."*
  - *"It's good that we, like, do it in partners because...if I was stuck, my navigator would help me."*