The Lawrence Hall of Science
UNIVERSITY OF CALIFORNIA, BERKELEY

PROGRAM BRIEF

# Science-Centered Content Integration: Advancing Interdisciplinary Learning and Equity in K-5 Classrooms

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## Introduction

In one Eastern Washington school district, elementary teachers are rallying around a focus on writing with their students and are integrating writing with their newly adopted science curriculum. On the western side of the state, another district is using grant funds to collaborate in working groups to create unit maps that leverage the integration between science and other subjects. In numerous districts across Washington state, instructional leaders and teachers are making similar groundbreaking shifts towards integrating math and English Language Arts (ELA) with science serving as the anchor. They are making system-wide efforts so that classroom instruction supports students in authentically engaging with meaningful reading, writing, and mathematics within the context of science.

These efforts are a part of Washington's Content Integration Project, launched by science leaders at the Washington Office of the Superintendent of Public Instruction (OSPI) and facilitated by the team at the Center for K-12 Science at the Lawrence Hall of Science (The Lawrence), a part of the University of California, Berkeley. This project came about because of alarming data showing how little time was being allocated or spent on science teaching and learning across K-5 schools in Washington. Together with project partners, OSPI and The Lawrence took a capacity-building approach that goes beyond isolated interventions–one that emphasizes the importance of systemic change to ensure lasting impact. The Lawrence engaged Washington leaders and leadership teams in applying systems-level thinking as a high-leverage strategy for driving equitable change towards increasing and improving science across schools.

## The Power of Content Integration

Why the focus on content integration anchored in science? In addition to providing more time for science instruction, decades of research show that interdisciplinary teaching and learning has many other benefits for teachers and students.

1. **Increases engagement and motivation.** Science as the anchor provides an engaging and rich context for learning about the world. Students are naturally curious and eager to explore phenomena that are interesting and relevant to their lives (NRC, 2012). They are more likely to stay engaged and motivated to learn when they see how concepts and practices connect within the disciplines through authentic learning experiences that center their interests. (Krajcik, 2023; Duke, 2021).
2. **Improves critical thinking and problem-solving skills.** The Next Generation Science Standards (NGSS) and the Common Core State Standards for English Language Arts and Mathematics require students to engage in high-level cognitive processes to develop and use models, analyze data, construct explanations, and argue from evidence (Lee, 2013). Leveraging the convergence of the NGSS practices

with those of mathematics, English Language Arts, and social studies provides students with more opportunities to engage in critical thinking and problem-solving across the disciplines.

3. **Deepens understanding of content knowledge and improves students' literacy skills.** There is an abundance of evidence-based research illustrating the synergy of science learning and literacy development. Students learn content by engaging in practices that involve reading, writing, speaking, and listening. Direct experiences with phenomena in the natural and designed worlds motivate students to learn and build foundational knowledge that they need to comprehend and create complex and specialized texts and engage in robust oral discourse (Cervetti, 2020; Kim, 2021). Studies have also demonstrated that the development of science and mathematical concepts and reasoning can be mutually supportive in the context of science learning experiences (Barrett, 2017; Tytler, 2020; Clements, 2021).
4. **Provides opportunities for social-emotional learning (SEL).** When engaging in science learning experiences, students develop cognitive and social-emotional skills together (Immordino-Yang, 2018). They build and apply their attentional and executive abilities as they share their observations and questions, work with others to plan and carry out investigations, and co-construct knowledge through sense-making activities (Learning Policy Institute, 2021; Bustamante, 2018). Districts that have successfully implemented SEL programs fully integrate SEL with academic learning for all students (Greenberg, 2023).
5. **Leverages the assets all students bring to the classroom.** When learning is focused on what is relevant to students, they can apply their knowledge and experiences to investigating and figuring out phenomena and designing solutions (Lee, 2021). Engaging in the science and engineering practices also provides multiple ways for students to communicate, such as talking, writing, drawing, and gestures (Ryoo, 2018; Lee, 2021)
6. **Encourages teacher collaboration and professional growth.** Planning for content integration requires teachers to collaborate. As they share their expertise in the different disciplines to build units together and create common assessments, teachers enhance their pedagogical content knowledge and ability to see the connections that are mutually supportive in multiple disciplines (Boche, 2021).

## Building Statewide Capacity: A Strategic Approach

Statewide capacity building efforts to implement content integration anchored in science present a strategic opportunity for system-wide change to prioritize and increase the quantity of elementary science. With this approach, comprehensive strategies can be deployed to enhance the coherence across multiple levels of leadership and educational agencies that might not typically coordinate or converse with each other. In this project, coherence-building strategies included:

- the mapping of curricula across subject areas;
- customized professional learning for educators and leaders; and,
- the establishment of statewide collaborative networks among individual teachers, schools, districts, and state regional leaders.

Such efforts were grounded in the recognition that effective content integration necessitates a systemic approach, ensuring that educators and leaders invested in content integration are equipped with the necessary mindsets, skills, and resources to implement and sustain integrated learning experiences (Garet, 2001; Fullan, 2011).

Still, taking a system-wide approach required tailored processes to guide educators and leaders along a developmental trajectory. This involved recognizing and addressing the varying levels of readiness and capacity among participants and necessitated strategies that acknowledged and adapted to the unique starting points and contextual factors of each educator and leader (Elmore, 2004; Coburn, 2003). Statewide leaders (e.g., science, math, ELA, and environmental learning) played a critical role in understanding the diverse educational contexts within their spheres of influence. This required a nuanced appreciation of the demographic, cultural, and organizational dynamics that influenced how and what could change and the related outcomes from this work. Statewide leaders advocated for policies and practices that supported equitable access to integrated learning opportunities, while also fostering and modeling a culture of innovation and collaboration.

Despite the strengths of this approach, several challenges were uncovered for agencies willing to replicate this model of building statewide capacity.

- The complexity of aligning curricula across subject areas and the diverse number of curricula adopted across the state,

- the need for extensive professional learning on the shifts of practice and mindsets,
- the need for allocation of time for leader and educator planning time, and
- the variability in local contexts that can affect momentum towards integration of math, ELA, and science.

Additionally, securing sustained funding and support for this kind of systemwide initiative remains a significant hurdle for those leaders looking to replicate this model. Nonetheless, the potential benefits of a well-implemented statewide capacity

building effort to increase the quantity and quality of science education are substantial, promising to enrich elementary student learning experiences and outcomes, and increase opportunity and access to science education statewide.

## Collaborative Infrastructure: Building a Strong Foundation

Establishing partnerships was a crucial component of the learning experiences for teachers and leaders and for furthering content integration anchored in science across Washington state. Partners included external content integration experts—researchers and open source curriculum developers—as well as internal partnerships with state- and district-level subject area instructional leaders and educators across (pre)K-5/6. Each group brought expertise to the project in terms of pedagogy, grade levels, subject areas, and knowledge of local and state implementation realities and resources that informed and enriched overall learning experiences for the leaders and the teachers.

The process to form partnerships began during the project planning phase, when we worked to establish an infrastructure to understand and value the role of each partner. The process included ensuring we make best use of their expertise, with the aim of creating high quality and coherent learning experiences for the cadres. The external content integration partners met as a team during the project launch phase to understand one another's roles and expertise and to become familiar with specific aims and goals for the project. We then revisited these ideas over the course of the year in order to design sessions that would be responsive to participant needs in their learning trajectory.

## Transformative Professional Learning: Our Innovative Process

The Lawrence engaged Washington education leaders in a holistic, research-driven professional learning experience. The professional learning program we established sought to foster both professional growth and the identification of allies to support the work of

### Who are the OSPI Content Integration Partners?

Many of the project's external partners came to the project having developed a set of standards-based science open education resources (OERs) integrated with ELA and/or Math. They facilitated sessions for the cadres in which they supported understanding of and use of the research-based approaches behind their OERs.

**ML-PBL (Multiple Literacies in Project-Based Learning):** Based out of Michigan State University, the ML-PBL team has developed project-based, literacy-focused elementary science OERs for grades 3-5.

**SOLID start (Science, Oral Language, and Literacy Development):** Based out of Michigan State University, these partners develop professional learning for teachers and standards-based, integrated science and disciplinary language and literacy curriculum materials designed for K-2 children.

**NYU SAIL (Science and Integrated Language):** Based out of New York University, this project developed integrated science OERs for grade 5, and shared expertise around language use in the science classroom.

Independent consultants formerly from **University of Texas at Austin's Dana Center:** These partners facilitated sessions and provided standards-based tools to leverage connections between elementary math and science.

content integration anchored in science. The sessions were customized with OSPI leadership serving as co-facilitators, enriched by state-related inputs, and were designed to integrate ongoing robust participant feedback.

We intentionally used principles of transformative professional learning in our program design. This kind of professional learning is intended to support changes in beliefs, knowledge, and habits of practice (Short, 2020). It incorporates active learning and builds on the assets educators bring to their own learning (NAESM, 2021). The following are selected key learning structures that allowed the participants, in various roles and abilities to influence change, to collaborate regionally and locally, and to examine the often invisible forces impeding transformative change.

**Job-Alike Conversations and Network Building.** The professional learning model embraced the premise that enabling the conditions for change is relational. Research tells us that externalizing and articulating our thoughts is helpful in meaning-making and connecting complex ideas more easily (Sawyer, 2006), yet in many cases leaders from different regions rarely have an opportunity to discuss aspects of their work with those in similar positions. The Lawrence purposely included numerous structured opportunities for participants to engage in strategic networking and discourse. The professional learning allowed the leaders to examine their roles, contexts, and actions more broadly, in timely job-alike discussions.

**Systems mapping & Problem Identi ication.** The professional learning emphasized problem articulation- what are the barriers to content integration anchored in science in a district or region? Participants and teams took the time to intentionally map out the components of their district or regional system. The Six Conditions of Systems Change Framework was used to help leaders take inventory of the policies and practices, resources, and mindsets in their systems (FSG, 2018). This problem articulation framework helps make problems and the parts of a system reinforcing the problem (the barriers) more visible. Each regional or district team was able to identify their barriers to content integration anchored in science, and articulate a problem in their system.

**Empathy Interviews.** In order to support the leaders in fully contextualizing their problem(s) or barriers and support the identification of more equitable and effective solutions, participants were tasked to conduct empathy interviews with those close to, or experiencing the problem(s) they had identified in their district or regional system. The empathy interviews elicited stories and new perspectives for the regional and district teams to consider and positioned the leaders to redefine the problem or barrier to content integration in their system. Being able to redefine barriers allowed teams to sometimes shift their understanding of what they needed to do to remove that barrier. One team uncovered that district communications about prioritizing science instruction were not being received by teachers as they had intended, allowing the team to reassess their messaging. This was not what they had originally identified as a barrier to prioritizing science yet was a relatively quick and straightforward shift.

## Learnings & Reflections: Insights from the Field

The importance of a systems change approach cannot be overstated as it involves restructuring existing mindsets, behaviors, frameworks, and practices to align with the goals of content integration (Senge, 2006; Fullan, 2007). It also requires a deep commitment to professional learning for multiple stakeholders, focusing on sense-making and reflective practices that are essential for navigating the complexities of our current K-12 systems. This project highlights the significance of these practices in fostering adaptive and responsive leadership and teaching. Collective sense-making enabled leaders to interpret and act upon the dynamic and often ambiguous challenges they faced with planning for and implementing content integration, while reflective practices encouraged continuous personal and professional growth.

By engaging in regular reflection, leaders critically assessed their actions, built a deeper understanding of their impacts, and developed more effective strategies for the shifts required with content integration. Real-world problems of practice also offered valuable learning opportunities for the project's educational leaders. Addressing how to implement content integration anchored in science required leaders to think about the ubiquitous issue of "not enough time for science during the school day." This required innovative solutions that went beyond traditional approaches of increasing access to science. Leaders who engaged in reflective practices identified root causes of these disparities, such as one leader whose job responsibilities included leading a science-specific professional learning community (PLC) with teachers at their school. This leader felt like they were facilitating teachers in the PLC without much direction or vision. They decided to shift the PLC direction into collectively identifying

a moment of math, science, and ELA intersection for their grade level and to create a "mini-lesson" that purposefully integrated the content for students. By analyzing data and reflecting on the implementation of the mini-lesson, the teachers were able to additionally design and create sample schedules to share with other teachers to improve general confidence in shifting towards content integration.

Uncovering new mindsets and insights is another critical component of effective leadership for content integration anchored in science. Through our professional learning program, leaders became increasingly open to discovering previously unnoticed factors that influenced the educational practices in their schools, districts, and regions–such as cultural biases that resulted in decreased access of science learning opportunities for multilingual learners, implicit assumptions for why science was not happening, and systemic inequities for both teachers and students when thinking about the quantity and quality of science education in schools and classrooms. Additional inequities were influenced by:

- the degree to which teachers have autonomy in their schedule and scheduling decisions (important for differentiation of instruction) versus compliance with curriculum scope and sequences (important for student access and equity);
- focusing on "power standards" (a subset of the grade-level standards that are frequently and formatively assessed);
- the employment of part-time specialists (which impacts school site master schedules);
- SEL instruction being separate rather than integrated; and,
- scope and sequence documents/requirements that tend to silo subjects instead of integrating them.

Realizing the explicit and implicit decision making that leaders themselves made, prompted efforts to revise scheduling policies and to engage in ongoing communication and curriculum guidelines to better integrate science into daily instruction.

The outcomes of the project underscore the importance of cultivating a mindset of inquiry and openness. In one district, a leader discovered through reflective practice, systems mapping, and ongoing problem articulation that select district schools often teach little to no science due to administrative mandates or beliefs about educational priorities. In particular, schools in this district with higher numbers of socioeconomically disadvantaged students are more likely to have placed science "on the back burner" and prioritize other subjects (e.g., math and ELA) over science instruction.

## The Road Ahead: Continuing the Journey

As with any systemic initiative to improve teaching and learning, change takes time and the effort of all stakeholders. As a result of the statewide focus on content integration anchored in science, the state of Washington has moved the needle toward their goal of increasing and improving science education for all elementary students. At the state leadership level, there is close collaboration across subject areas and departments and regular meetings with the State Superintendent of Washington around content integration and advancement of equitable science learning opportunities for elementary students. To support planning and innovative project development, the state has awarded, and continues to award, various integration implementation grants to schools and districts. These projects are then showcased across the state so that teachers and leaders can share their successes and inspire other educators to engage in content integration work in their systems. The message that content integration is effective, achievable, and supported by state educational leaders is being heard loud and clear in Washington and across the country as a model for addressing the lack of time spent on science education at the elementary level.

Moving forward in other states, in addition to the math-science-ELA content integration, the Lawrence team is now focusing on efforts to deepen the connections between STEM teaching and learning and computational thinking as K-12 systems prepare students for an increasingly computational world. As more and more districts and schools broaden the focus of their educational initiatives to grow student critical thinking and problem-solving skills, the Lawrence is committed to providing transformative professional learning opportunities and technical assistance to K-12 systems. Shifts to K-12 systems can be challenging; however, working together across disciplines, and in community with external partners, can both catalyze efforts and create momentum to bring more, better, and equitable science back to the elementary school classroom.

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