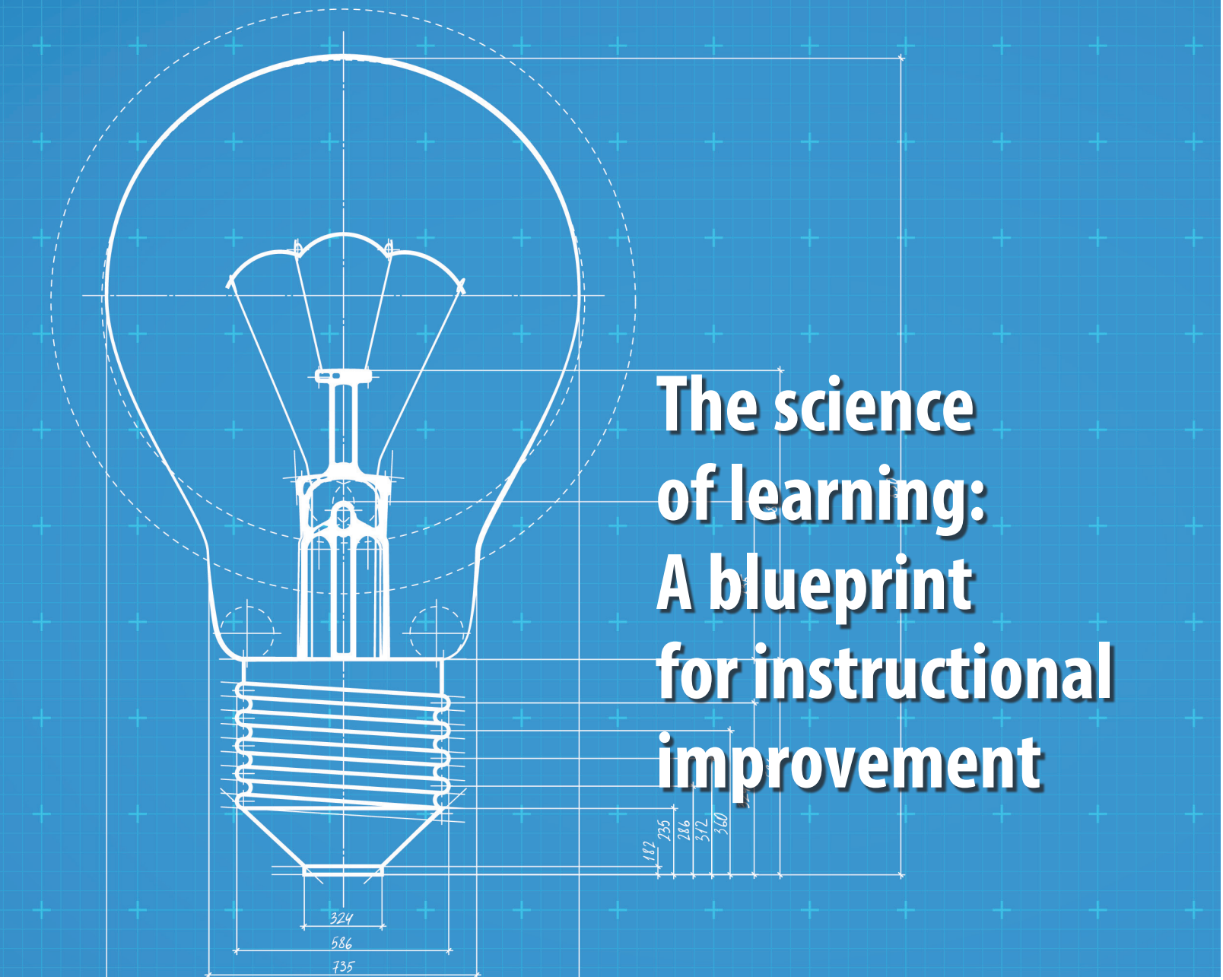

The science of learning: A blueprint for instructional improvement

BY JIM HEAL AND MARGARET (MEG) LEE

Achieving meaningful results from professional learning presents many of the same challenges we encounter when organizing for student learning. We strive to create environments characterized by deep processing, authentic application, and sustained practice. But just as fragile student learning can dissipate the moment students hand in an exam, teachers' strategies and instructional practices can flicker and fade, even when early results suggest successful transfer of learning, only to be pushed aside by the next initiative.

This all-too-familiar scenario may lie in how we have historically conceptualized professional learning: less like a sturdy structure and more like surface decoration, outwardly attractive and exciting at first glance, but ultimately superficial and short-lived. After all, decorations can make a place feel new, but they do not alter the integrity of the building.

Fortunately, the emerging influence of learning science offers a different proposition. It invites us to reject

the surface phenomena of intuition, tradition, and isolated strategies in favor of a shared, evidence-informed understanding of learning. When the science of learning becomes structural — embedded in professional learning, classroom practice, leadership decisions, and strategic priorities — it has the potential to transform entire schools and systems.

THE BLUEPRINT: WHAT WE MEAN BY THE SCIENCE OF LEARNING

The science of learning draws on a body of research spanning several disciplines — cognitive science, educational psychology, and instructional design — to examine how humans acquire, retain, and utilize knowledge. At its core, an essential question drives the field: How does learning happen, and how should we teach as a result?

Over decades, research has produced some remarkably consistent answers to that question. We know for instance that learning involves the gradual construction of knowledge in long-term memory. It requires effortful thinking, the integration of new information with prior knowledge, and opportunities to retrieve and apply what has been learned. Instruction that supports such principles is more likely to lead to durable learning, while teaching that bypasses them often leads to student outcomes that are more fragile or fleeting.

Daniel Willingham (2009) has described this distinction as brittle knowledge versus flexible understanding, and it's just as true for teachers as it is for students. When educators adopt techniques without grasping underlying principles of the mind, their practice becomes brittle — easily disrupted by the shifting conditions of schools.

The science of learning offers a powerful lever for addressing both student learning and teaching practice, but that change can only happen through the coordinated efforts of constituents across the system. Let's explore how four essential roles — teachers, teacher leaders, principals, and district-level leaders — can support the development of an evidence-informed culture.

Teachers: Skilled craftspeople

Teachers make moment-to-moment instructional decisions that shape student thinking in subtle but significant ways. The science of learning can provide a foundation on which to base these moves, not by mandate but as a lens through which to consider and hone practice. The distinction between strategies and principles is crucial here. Strategies are often what teachers engage with first, since they promise a ready-for-use approach. But strategies alone are like surface fixtures: useful only when attached to an underlying structure.

Consider for instance retrieval practice, the act of intentionally recalling information from memory in order to improve the long-term retention of concepts (Karpicke & Blunt, 2011). Every time a learner has to fetch a piece of information from their long-term memory, it strengthens the trace associated with that knowledge, making it more accessible for future use. Without an understanding of how memory works, retrieval could easily be mistaken for simple quizzing. In reality, we know that retrieval is not a test of learning; it *is* learning.

When teachers understand retrieval first as a principle of the mind *before* considering it as a practical strategy, they can transform its use in the classroom beyond simple testing to a mechanism that supports student learning.

Supporting instructional improvement in this way, through the lens of learning science, provides an antidote to ineffective methods of professional learning in which teachers leave with a grab-bag of techniques but little idea about how to apply them. Instead, as in other fields such as medicine, law, or engineering, a principles-first approach to instruction empowers practitioners to blend the best of their professional expertise with the best available professional knowledge.

Coaches and teacher leaders: Site supervisors

Instructional coaches and teacher leaders occupy a unique position between the classroom and the wider life of school. At their most effective, coaches act as connectors, supporting teacher development by aligning specific instructional aims with an

ever-evolving understanding of how learning happens.

In some schools, however, coaching can inadvertently reinforce the decorative aspects of instructional improvement. Coaches may introduce observational rubrics or debrief protocols without anchoring them in a coherent model of learning. From there, feedback can slip into generalized impressions ("The students seemed really engaged!") that ultimately fail to support teacher improvement.

Consider instead a coaching approach that utilizes the science of learning as its jumping-off point. After infusing the concept of effortful thinking (Kraik & Lockheart, 1972) into the coaching process, a coach might say during a one-on-one session with a teacher, "I'm going to observe you next week with a focus on how you prompt your students to think effortfully. We know the longer a learner stays at the site of meaningful thinking, the more likely it will be that the concept in question passes into their long-term memory. Let's develop some strategies to help students stay longer with an idea, rather than having them move briskly on to the next concept. After I observe, we can unpack how this strategy made a difference."

Notice how the coach is drawing on an established common language of evidence-informed instruction to highlight a specific term (effortful thinking) with which the teacher is familiar. Notice also how the specificity with which the coach defines the principle determines the specificity with which they can observe and explore the practice. This approach also smooths the relational aspect of the coaching process, since it invites a collective consideration of student thinking rather than the coach evaluating or scrutinizing the actions of the teacher.

Coaching guided by evidence allows for a forensic approach to instructional design and delivery rather than an evaluative one. It invites teachers to look closer, see more, and understand the *why* behind their instructional decision making. When enacted with integrity, this helps teachers develop greater degrees of intention and agency in their professional growth.

Principals: Architects of culture

When building toward school improvement, principals have a host of levers at their disposal: the professional learning materials in which they invest, the time they allocate for teachers to refine their practice, even how they choose to communicate schoolwide priorities. When used effectively, these levers offer structure and purpose, but often it's difficult for a leader to know where and why to place their bets unless they have an evidentiary cornerstone upon which to make those decisions.

The science of learning provides principals with an evidence-informed lens they can use to shape professional learning as integral to the structure of the school, not a tangential add-on or series of isolated events. It also helps them frame problems of instructional improvement effectively. Lacking that lens can lead to jumping to solutions without properly understanding the need, which can mean the school's day-to-day activities run contrary to the evidence-informed culture its leader is trying to foster in the first place.

Take cognitive load theory, the idea that we can only hold a small number of knowledge items in our working memories at any time, and exceeding that amount makes learning practically impossible (Sweller, 1988). This is true for adults just as it is for students. Yet some principals send Monday morning all-staff emails with 17 items to consider for the coming week. Not only is this likely to cognitively overwhelm teachers at an individual level, the school itself could arrive at a kind of cognitive overload in which the sheer number of priorities becomes too much for the community to bear.

The same happens when leaders switch from initiative to initiative in an attempt to hit the sweet spot of school improvement. We have visited schools that were proud to tell us this year was "The Year of the Brain," to which we would say you wouldn't go to a dentist with a sign over the door that read "The Year of the Tooth." In reality, every year should be the year of the brain, and a leader's job is to provide a degree of permanence that says, "This is the way we do things around here."

Rather than offering up a steady stream of initiatives that eventually collapse under their own burden, effective principals determine the weight and rate of change a school can hold. They right-size that change by employing principles of learning to decide what to pick up, what to put down, and what to sustain. When leaders frame change in these ways, and schools arrive at a collective instructional focus grounded in the best available knowledge, colleagues begin to feel agency and alignment where they once felt chaos and overwhelm.

District leaders: Structural engineers

District-level leaders shape the very foundations upon which schools operate, employing strategies that include curriculum adoption, professional learning priorities, coaching practices, and evaluation frameworks. Learning science principles can inform all of these and improve the coherence of the system. But just as these policies can be used for good, they can, with the best of intentions, end up having the opposite effect.

Take the principle of automaticity, the idea that effective practice builds a learner's ability to perform tasks without conscious deliberation, thus freeing up limited working memory to concentrate on higher levels of cognition (Logan, 1988). A district-level leader with a robust understanding of automaticity would be well positioned to choose a math curriculum that maximizes students' learning potential. When presented with a math curriculum that claims to be evidence-based but is built on the assumption that memorization of foundational mathematical knowledge is unnecessary, they would know not to waste valuable

resources on this program. They would know that students who are expected to recall math facts at the same time they are applying them are likely to become cognitively overwhelmed, whereas students who have achieved automaticity and already have math facts at their fingertips can free up cognitive bandwidth to take on the problems in question.

To make teaching practice effective at scale, everyone in the system needs to have a shared, precise definition of effective teaching practice in the first place. This coherence begins at the top. District-level leaders should not be exempt from their own journey to better understand how learning actually occurs, because knowing what works is the foundation for policy decisions both small and large.

When district leaders use the science of learning to ground strategy in what is educationally legitimate and viable, we find systems that are not so tightly fixed that they become resistant to change, while still not being so loosely organized that everyone adheres to idiosyncratic, potentially mutated versions of what good teaching and learning looks like. Learning science principles act as the cohesive force that helps leaders hold the collective vision in place and guides stakeholders to avoid the common phenomenon of chasing the next shiny ornament or fad.

EQUITY BY DESIGN

One of the most powerful implications of an evidence-informed structure to teaching and learning lies in its potential to advance learning for all students regardless of their backgrounds. Discussions of inclusive schooling often focus on ideas of belonging and cultural responsiveness — considerations that, while essential, only establish the conditions within which learning can take place, not the nature of that learning. Learning science offers us another dimension to consider: instructional equity. Instructional equity begins with the premise that meeting the needs of all learners cannot happen as a matter of broad intention. It must play out in the thousands of instructional moves that happen in real classrooms every day. Therefore understanding how certain moves support or impede the learning of all students becomes imperative.

Let's consider the principle of prior knowledge (Bransford & Johnson, 1972): For new knowledge to move into our long-term memory, it requires relevant, accurate prior knowledge onto which it can stick. This essentially means that the more a student knows about a particular topic, the more they can learn about it. The corollary of this principle is that a lack of prior knowledge makes it harder for new knowledge to move into long-term memory. This helps explain why achievement gaps exist and widen over time. When classroom instruction systematically builds new knowledge onto existing understanding, we increase the likelihood that all students will have access to the ideas they need to succeed.

This has huge ramifications for equity and invites questions about who benefits most from schooling as it is currently structured. If knowledge is a currency, whose currency is accepted within our classrooms? Who among our students gets to think? Who gets to think deeply? What happens if the race, culture, or lived experiences of some students doesn't happen to adhere to the prior knowledge assumptions we as teachers draw upon when designing instruction? We need to ask these questions and address them so we are not leaving instructional equity to chance. We need to engage teachers in ensuring instruction is working for *their* school, *their* classroom, *their* students — *all* students.

Schools will not realize an evidence-informed, equity-driven vision of teaching and learning at scale by accident. It requires commitment at all levels and in all roles. This includes teachers who can hone their craft with evidence in mind and coaches who can connect instructional improvement to underlying principles of learning. It also includes school leaders who can build culture around accumulative, instructionally focused professional learning and district leaders who can align policies, resources, and strategies around a shared vision of excellence grounded in our best understanding of how learning happens.

The science of learning offers education something it has long needed: not a new coat of paint, but a blueprint for building effective, equitable systems that endure.

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