Educator Learning to Enact the Science of Learning and Development

Linda Darling-Hammond, Lisa Flook, Abby Schachner, and Steven Wojcikiewicz
in collaboration with Pamela Cantor and David Osher
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LEARNING POLICY INSTITUTE

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Executive Summary

Research advances in neuroscience and the developmental and learning sciences have provided us with important insights about how people learn and develop. The knowledge we now have points to important transformations in teaching practice, which in turn require transformations in educator development needed to support all educators in developing the knowledge, skills, and dispositions associated with developing the whole child. This report synthesizes research on how to support educators in developing those capacities both in preservice and in-service contexts. We take up both the "what" of teacher and leader preparation—the content educators need to learn about children and how to support their development and learning—and the "how"—the strategies for educator learning that can produce deep understanding; useful skills; and the capacity to reflect, learn, and continue to improve.

Foundations for Educator Preparation

Syntheses of advances from the science, linked to educational research, have identified implications for practice of the science of learning and development and a set of design principles for schools for putting the science of learning and development into action. These syntheses point to the following principles as a foundation for educators' knowledge base:

- The brain and development are malleable across the entire life span in response to relationships, experiences, and contexts.
- Variability in human development is the norm, not the exception.
- Human relationships catalyze healthy development and learning.
- Learning is social, emotional, and cognitive.
- People actively construct knowledge based on their experiences in social and cultural contexts.
- Adversity affects learning—and the way schools respond matters.

Developing the kinds of skills currently required in a fast-changing knowledge-based society requires a different kind of teaching and learning from prior eras of education when learning was conceptualized as the acquisition of facts and teaching as the transmission of information to be taken in and used "as is." This means students need opportunities to set goals and assess their own work and that of their peers so that they become increasingly self-aware, confident, and independent learners. To become productive citizens within and beyond the school, students also need positive mindsets about self and school, along with social awareness and responsibility.

The ability of schools to help achieve these outcomes requires environments, structures, and practices attuned to students' learning and developmental needs. These include:

- positive developmental relationships;
- environments filled with safety and belonging;
- rich learning experiences that support deep knowledge development;
- development of social, emotional, and cognitive skills, habits, and mindsets; and
- integrated support systems.

What Do Educators Need to Know and Be Able to Do?

The National Academy of Sciences frameworks from two volumes on *How People Learn* suggest that common practices of effective teaching draw on several areas of knowledge:

- how students learn and develop within social contexts, including how cultural, social, emotional, and physiological experiences influence learning;
- how subject matter and curriculum goals can be taught in light of the social purposes of education; and
- how teaching can be structured in light of the content and learners to be taught, as informed by assessment and supported by a productive classroom environment that fosters the sense of belonging, agency, and purpose that supports motivation.

These areas of knowledge must be joined with skills of curriculum design and instruction, inquiry, reflection, and diagnosis to produce the adaptive expertise that enables teachers to make the connections between children and content that are necessary for learning. And these skills must be further joined to dispositions and attitudes that support empathy, social-emotional capacity, cultural competence, and a commitment to equity in support of each child's well-being. School leaders need additional knowledge and skills to create the environments in which children and educators can thrive. These include an understanding of the pedagogical practices that support deep learning for children and adults; knowledge and skills for instructional leadership; and collective leadership practices that support collaborative buy-in from teachers, families, and others.

How Educators Can Develop the Necessary Knowledge, Skills, and Dispositions

Just as the call to utilize the science of learning and development to shape schoolwide practice places significant new demands upon educators and schools, so too does the need for educators to learn how to implement such practices place significant new demands upon educator preparation and professional development.

Designing learning experiences for adults

In order to design learning opportunities that are effective and useful for educators, an understanding of adult learning theory is essential. Adults bring with them substantial prior knowledge and interpreted experience, and they may have fixed ideas or preconceptions that influence their receptivity to new information. Theoretical frameworks in adult learning emphasize that learning should be related to adult learners' prior experiences and professional purposes, ensure real-world applications, and allow learners to understand and experience the perspectives of others, so they can transform their own preconceptions into more responsive practices.

Key Strategies and Practices for Educator Preparation

Challenges of learning to teach for deeper learning and equity

The design of effective preparation programs must contend with at least three well-known challenges of learning to teach:

- The problem of the "apprenticeship of observation"—learning to teach requires a reframing of educators' own previous experience as students in order to think about and understand teaching in new ways.
- The problem of enactment—teachers need not only to learn, but to learn to *do*.
- The problem of complexity—learning to teach requires that new teachers act purposefully to achieve multiple goals within a complex and busy classroom full of students who each bring their own knowledge, ideas, and social and cultural experiences with them.

These problems, along with the necessity of attending to the needs of adult learners, create parameters for prospective teachers' learning that should guide the design of effective programs.

Key strategies for educator preparation program design

Program design should center around a coherent vision of whole child development, learning, and teaching that includes:

- pedagogical alignment around a coherent vision of whole child development, learning, and teaching that enables new teachers and school leaders to experience the very kinds of teaching strategies they are expected to develop for the pupils they work with;
- well-designed clinical experiences tightly linked to coursework that, together, integrate theory and practice to instantiate the developmental principles educators need to learn; and
- a developmental approach to the development of educators (just as educators use with their students) that occurs experientially in contexts that consciously support educators to go through the stages that eventually allow them to become increasingly expert.

Key practices for educator preparation

These overarching strategies support a set of educator preparation practices that research has shown make a strong difference in the capacities of educators. These key practices for educator preparation include:

- anchoring candidate learning in the study of human development and learning—in all its diversity—as the foundation and guide for the use of all other knowledge about teaching;
- integrating theory and practice through clinical experiences and coursework that allow teachers to learn and practice ever more sophisticated applications of knowledge and skill to reach greater mastery;
- providing opportunities for authentic practice, assessment, feedback, and reflection to accelerate learning;
- engaging in inquiry and analysis strategies that guide reflection and application, preparing candidates to ask productive questions when they encounter novel teaching challenges in different schools and community contexts and to employ such strategies with their own students; and
- collaborating in professional learning communities that provide mutual support, opportunities to learn from others' perspectives and expertise, and modeling for leading a collaborative classroom.

Creating Systems That Support Educator Learning

Since children are not standardized and problems of practice are never routine, educators also need opportunities to continue to learn once they leave initial preparation. Effective professional development models that support educators' practice share several features. These approaches:

- are content focused,
- incorporate active learning,
- support collaboration and space for teachers to learn together,
- use modeling of effective practice,
- provide coaching and expert support,
- offer opportunities for feedback and reflection, and
- are sustained over time.

Professional learning is most effective when it is part of a sustained approach at the school, district, and network levels that creates opportunities for learning, dialogue, and the development of shared practices at all levels of the system and among all of the members of the school community. An example of a successful schoolwide approach is the School Development Program, which teaches all members of the school community to use the principles of child and adolescent development to create a positive environment for children's development along all of the developmental pathways—physical, social and emotional, linguistic, and cognitive.

Some schoolwide approaches, like the School Development Program, EL Education, and Institute for Student Achievement, have evolved into networks of schools that have been developed around practices grounded in the science of learning and development. These networks hold promise as a catalyst for developing educator capacity to address complex educational problems. Districtwide approaches that iterate on learning opportunities to deepen teachers and principals' understanding, as well as district-level supervision and supports, are also important for sustained and successful transformations in pedagogy and school practice.

Conclusion

Concentrated efforts will be needed to create professional learning opportunities that can help educators develop the kinds of knowledge, skills, and dispositions needed to enable educators to use the insights from the science of learning and development to support their students through safe communities and secure relationships; integrated social, emotional, and academic supports; and the kinds of teaching that enable children ultimately to guide their own learning.

These efforts will be most successful if they offer pedagogical alignment that allows educators to experience the same kinds of learning they will use with students and if they engage educators in sustained, collegial efforts to practice new skills and strategies, while parallel learning and redesign occurs in districts' central systems.

Introduction

Over the last several decades, we have learned a great deal about how people learn and develop from research in neuroscience; the developmental and learning sciences; and fields like anthropology, sociology, and social psychology. Recent syntheses of this research and its implications for educational practice, published in a series of articles in *Applied Developmental Science*,[1] have pointed to important transformations in teaching practice needed to ensure that children experience the secure relationships, skillful teaching, and personalized supports that will enable healthy development and successful lives, including for those who have experienced adverse conditions.

The knowledge that we now have causes us to affirm many principles of developmentally appropriate practice that were uncovered more than a century ago, while simultaneously requiring us to challenge assumptions that drove the design of 20th-century education. These assumptions still live at the core of instructional practice, school organization, and policies governing everything from testing and the allocation of curriculum to school discipline. This knowledge unseats old assumptions that intelligence is genetically determined and fixed at birth, that school opportunities are appropriately allocated based on tests that rank children in terms of their different potential, that learning follows a uniform trajectory and is best accomplished by memorizing ordered information, and that punishment effectively guides behavior.

This knowledge unseats old assumptions that intelligence is genetically determined and fixed at birth, that school opportunities are appropriately allocated based on tests that rank children in terms of their different potential, that learning follows a uniform trajectory and is best accomplished by memorizing ordered information, and that punishment effectively guides behavior.

The needed transformations—from assembly line school designs, standardized teaching practices, norm-referenced testing, and exclusionary discipline to supportive communities that enable personalized attention to the development of human potential—create a tall order for educators. To accomplish this goal, educators need not only deep knowledge of how children develop and learn, but also the skills to transform that knowledge into supportive schoolwide practices in organizations that were not typically designed to develop children holistically or to build on their cultural experiences and prior knowledge to create success for each of them.

To be sure, there are exceptional schools that accomplish these goals, and there are exceptional preparation programs that support both teachers and school leaders in this work.[2] They are not the norm, however, for a range of reasons. These include a failure to organize the knowledge base in a manner that can be readily accessed and deeply understood by practitioners and their preparers; a failure to challenge policies and practices in both schools and the broader society that inequitably allocate opportunities to learn, largely on the basis of race and class; and a failure to undertake the steps needed to fully professionalize teaching so that all educators enter with the knowledge, skills, and dispositions needed to support the learning and development of all children. This would require

updated standards that are enacted through purposeful accreditation of programs and licensing expectations that are not waived in order to fill vacancies while keeping salaries low, especially in the under-resourced schools that serve students of color and those from low-income families.[3]

To take advantage of our growing knowledge, we will need comprehensive efforts to support all educators in developing the knowledge, skills, and dispositions needed to develop the whole child—including children's social, emotional, and cognitive development; their physical and mental health; and their identities, interests, passions, and skills for learning. We will also need a social commitment to provide the resources to enable all educators to gain access to the preparation and ongoing training they need and to enable all children to gain access to these well-prepared educators.

In this report, we take up the question of educator development for enacting the science of learning and development, examining both the "what" of teacher and school leader preparation—the content educators need to learn—and the "how"—the strategies for educator learning that can produce deep understanding; useful skills; and the capacity to reflect, learn, and improve.

Foundations for Educator Preparation

A synthesis of scientific advances linked to educational research[4] has identified "implications for practice of the science of learning and development"[5] and a set of "design principles for schools." This work is putting the science of learning and development into action.[6] The science syntheses point to the following principles that provide a foundation for educators' knowledge base:

1. **The brain and development are malleable.** The brain grows and changes throughout life in response to experiences and relationships. The nature of these experiences and relationships matters greatly for development: Optimal brain development is shaped by warm, consistent relationships; empathetic back-and-forth communications; and modeling of productive behaviors. The brain's capacity develops most fully when children and youth feel emotionally and physically safe; when they feel connected, supported, engaged, and challenged; and when they have rich opportunities to learn, with materials and experiences that allow them to inquire into the world around them.

2. **Variability in human development is the norm, not the exception.** The pace and profile of each child's development is unique. The pathways by which children develop their skills and talents are both individual and jagged, characterized by ups and downs instead of lockstep progress. This means that all learning is variable. Because each child's experiences create a unique trajectory for growth, there are multiple pathways—and no one best pathway—to effective learning. Rather than assuming all children will respond to the same teaching approaches equally well, effective teachers personalize supports for different children, and effective schools avoid prescribing learning experiences around a mythical average. When schools try to fit all children to one pace and sequence, they miss the opportunity to reach each child, and they can cause children to adopt counterproductive views about themselves and their own learning potential, which undermines their progress.

3. **Human relationships catalyze healthy development and learning.** Supportive, responsive relationships with caring adults are essential for healthy development and learning. Such relationships can buffer the potentially negative effects of even serious adversity. When adults have the awareness, empathy, and cultural competence to appreciate and understand children's experiences, needs, and communication, they can promote the development of positive behaviors and confidence to support learning.

4. **Learning is social, emotional, and cognitive.** Emotions and social relationships affect learning. Positive relationships, including trust in the teacher, and positive emotions, such as interest and excitement, open the mind to learning. Negative emotions such as fear of failure, anxiety, and self-doubt reduce the capacity of the brain to process information and to learn. Learning is shaped both by intrapersonal awareness, including the ability to manage stress and direct energy in productive ways, and by interpersonal skills, including the ability to interact positively with others, resolve conflicts, and work in teams. These skills can be taught.

5. **People actively construct knowledge based on their experiences, relationships, and social contexts.** Children, youth, and adults dynamically shape their own learning. Learners connect new information to what they already know in order to learn. This process works best when students engage in active, hands-on learning and when they

can connect new knowledge to personally relevant topics and lived experiences. Effective teachers draw those connections, create engaging tasks, watch and guide children's efforts, and offer constructive feedback with opportunities to practice and revise work toward growing competence.

6. **Adversity affects learning—and the way schools respond matters.** Each year in the United States, 46 million children are exposed to violence, crime, abuse, or psychological trauma, as well as homelessness and food insecurity. These adverse childhood experiences can create toxic stress that affects attention, learning, and behavior. Poverty and racism, together and separately, make chronic stress and adversity more likely. In schools where students encounter punitive discipline rather than support for handling adversity, their stress is magnified. Schools can buffer the effects of stress by creating supportive environments that are personally attentive and culturally responsive, facilitating supportive adult–child relationships that extend over time, teaching social-emotional skills, and offering integrated student supports that enable healing and recuperation as they remove obstacles to learning.

These bodies of research tell an optimistic story about each child's potential and the ways in which environments, experiences, and relationships can be organized to support the expression of that potential. Additionally, as the brain becomes increasingly integrated, the developmental process features multiple critical periods, including adolescence, when young people develop new metacognitive capabilities that they can draw upon to better interpret and use new experiences, thus becoming more self-managing in their own learning process.

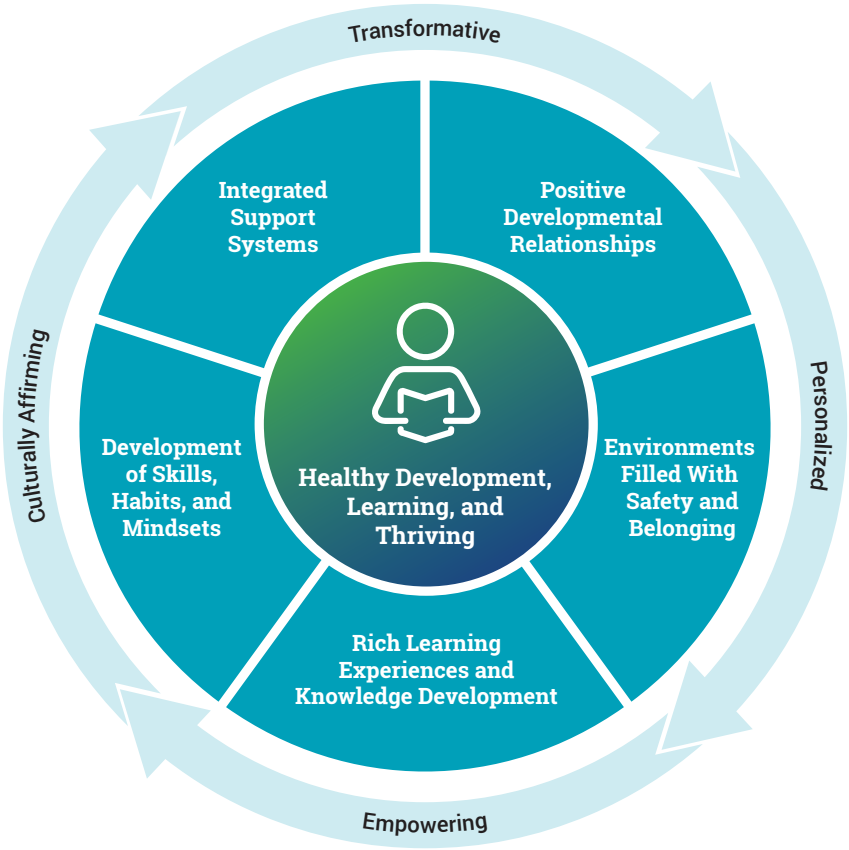
This capacity for self-regulation and self-direction in learning is critically important today. As outlined in the "Implications for Practice" synthesis,[7] the kind of learning today's young people need to engage in is grounded in a context in which knowledge is rapidly expanding and technologies are rapidly changing. To manage new knowledge and succeed in the face of these ongoing changes, children need well-developed critical thinking and problem-solving skills; the capacity to find, analyze, synthesize, and apply knowledge to novel situations; interpersonal skills that allow them to work with others and engage effectively in cross-cultural contexts; self-directional abilities that allow them to manage their own work and complex projects; the ability to competently find resources and use tools; and the capacity to communicate effectively in many ways.

Developing these kinds of skills requires a different kind of teaching and learning from prior eras of education when learning was conceptualized as the acquisition of facts and teaching as the transmission of information to be taken in and used "as is." For example, a review of research by the National Research Council indicates that the kind of learning supporting these higher-order thinking and performance skills is best developed through inquiry and investigation, application of knowledge to new situations and problems, production of ideas and solutions, and collaborative problem-solving.[8] These tasks, in turn, require strong self-regulation, executive functioning, and metacognitive skills; resourcefulness, perseverance, and resilience in the face of obstacles and uncertainty; the ability to learn independently; and curiosity, inventiveness, and creativity. This means students need opportunities to set goals and assess their own work and that of their peers so that they become increasingly self-aware, confident, and independent learners. To become productive citizens within and beyond school, students also need positive mindsets about self and school, along with social awareness and responsibility.[9]

The ability of schools to help achieve these outcomes requires environments, structures, and practices attuned to students' learning and developmental needs,[10] including:

- **positive developmental relationships**, which support children's attachment to caring adults and a supportive peer community, as well as their growth and development;
- **environments filled with safety and belonging**, which are not only physically safe, offering consistent norms and routines, but also emotionally and identity safe, so that all children know they are a valued part of the school community;
- **rich learning experiences that support deep knowledge** through authentic activities that build on prior knowledge and cultural contexts, enabling children to work collaboratively with peers to develop transferable knowledge and higher-order thinking skills;
- **development of skills, habits, and mindsets** that foster social, emotional, and cognitive capacities in support of personal and interpersonal awareness, empathy, perseverance, and resilience; and
- **integrated support systems** providing readily available academic, health, mental health, and social service supports that remove obstacles to learning and support thriving.

Figure 1
Guiding Principles of Equitable Whole Child Design



Source: Learning Policy Institute & Turnaround for Children. (2021). *Design principles for schools: Putting the science of learning and development into action*. https://k12.designprinciples.org/.

To accomplish these goals, school staff and leaders need a common knowledge base about child development across all of the domains and about learning in the many ways it unfolds for diverse learners. Teachers, principals, and other school leaders also need a common understanding of the practices that can support optimal learning and development. These understandings include:

- Knowledge of how to design **supportive school organizations** so that these organizations provide for strong, continuous relationships; shared norms and practices rooted in a common understanding of child and adolescent development; equitable access to knowledge, skill development, and engaging learning experiences for children; and strong relationships with families. These features are not easily achieved in the factory-model designs for schools that originated more than a century ago, and they typically require important changes in the "regularities of schooling."[11] Thus, educators also need **skills for change management and collaboration** to transform existing contexts.

- Knowledge of **productive instructional strategies that enable teachers to support students' motivation, competence, self-efficacy, and self-directed learning.** Pedagogical content knowledge and skills, combined with knowledge of child development, help teachers create meaningful curriculum that builds on students' prior knowledge and experiences. Such knowledge and skills can also help educators develop rich inquiry tasks that are thoughtfully interwoven with explicit instruction and well-scaffolded opportunities for students to practice and apply their learning, including well-designed collaborative learning opportunities that encourage students to question, explain, and co-construct solutions. These experiences are part of a mastery approach to learning, supported by performance assessments that incorporate opportunities to receive helpful feedback, develop and exhibit competence, and revise work to improve. They also give students opportunities to develop metacognitive skills through planning and management of complex tasks, self- and peer assessment, and reflection on learning.

- Knowledge of **practices that enable educators to support students' social, emotional, and cognitive development**, along with their academic, moral, and identity development. This knowledge includes an understanding of how to teach social-emotional skills while creating classroom communities and "identity-safe" environments[12] in which children can experience belonging, affirmation, and opportunities to extend their skills at the edges of their zones of proximal development.[13] Such knowledge must be accompanied by the **skills to put developmental knowledge into practice**—the capacity to closely observe children, to scaffold and affirm their efforts, to describe and model desired behaviors, and to create productive tasks that move them forward.

- Knowledge and skills for **identifying and addressing individual needs** that are associated with learning barriers, adverse conditions, or trauma. This knowledge includes an understanding of learning differences and disabilities and strategies for addressing these needs, as well as an understanding of how trauma affects student learning and behavior, how to access resources in a multi-tiered system of support, and how to support student resilience. For teachers, this includes **diagnostic skills** to learn what children are experiencing and what they need, and **instructional and interpersonal skills** to address these needs to the extent possible within the classroom and to build seamlessly and with

care and discretion on outside-of-classroom resources that may also be needed. For school leaders, this includes **skills for organizing systems and programmatic supports** that are readily available when needed, without delay or stigmatization of students.[14]

In subsequent sections, we outline, first, what teachers need to know and be able to do to support student development and learning, and then what school leaders need to know and be able to do to create environments that allow for and encourage these practices. These capacities include knowledge, skills, and dispositions that can support children and engage their families in thoughtful, culturally competent, and equitable ways. Next, we discuss how educators can develop these capacities in both preservice and in-service learning contexts, with particular attention to the strategies that have been found useful in helping educators develop effective practices that incorporate and enact theoretical understanding. Finally, we discuss what is known about how to create systems that can support this kind of professional learning so that it is regularly and routinely available in high-quality ways.

What Do Educators Need to Know and Be Able to Do?

After publication of the National Academy of Science's report *How People Learn*,[15] the National Academy of Education (NAE) convened a panel of researchers to examine the research on practices teachers can engage in to support effective learning and on strategies that enable teachers to learn these practices. The resulting report, *Preparing Teachers for a Changing World: What Teachers Should Learn and Be Able to Do*, outlines both the content and processes that should be part of teacher education in order to develop teachers' knowledge, skills, and dispositions to be able to teach diverse students in ways that foster deep learning.[16]

Teacher Knowledge That Supports Student Learning and Development

The NAE framework suggests that the common practices of effective teaching draw on three general areas of knowledge that beginning teachers must acquire in order to be successful with their students (Figure 2). We use these areas of knowledge as organizers for this section:

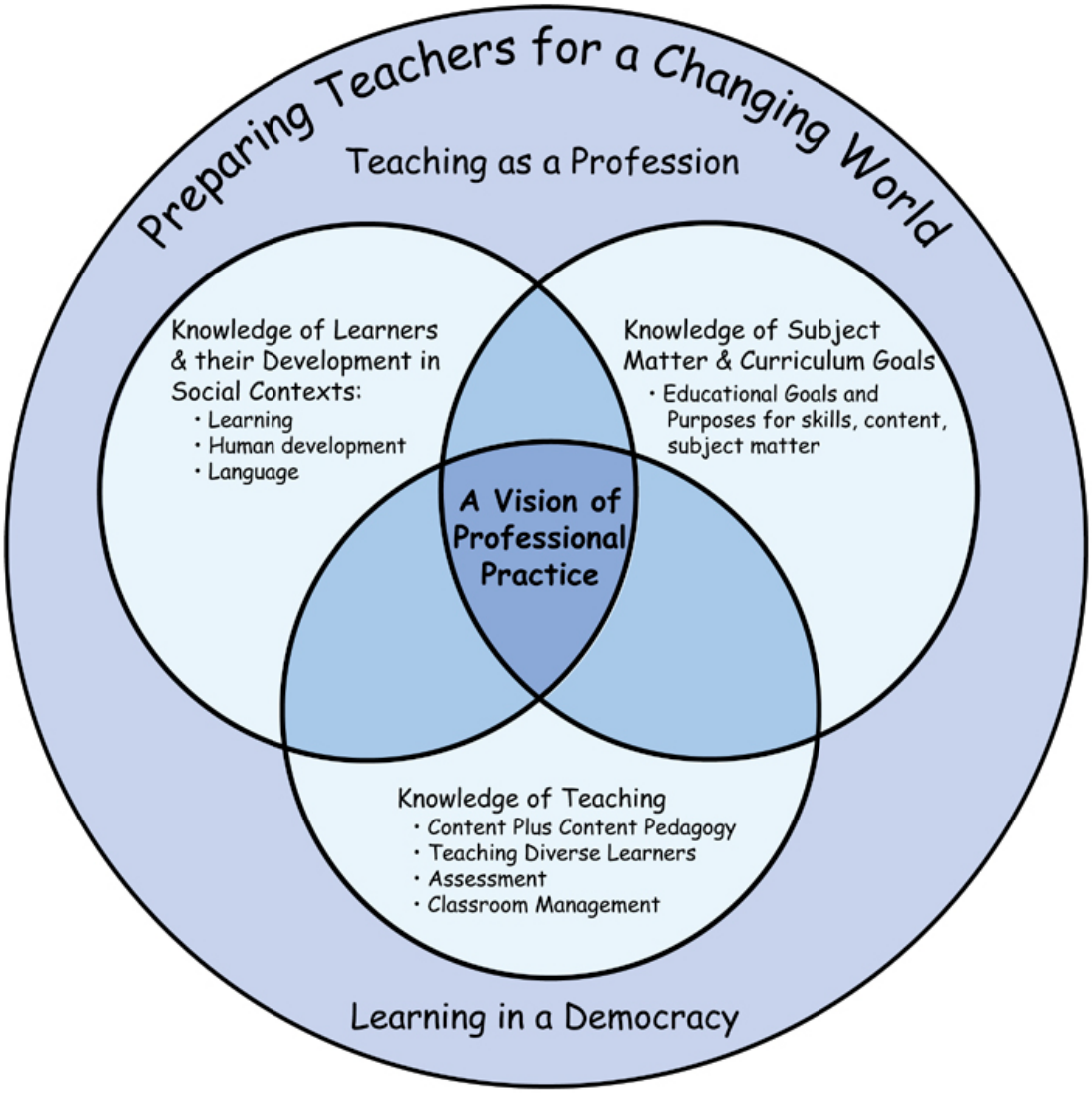
- Knowledge of **learners** and how they learn and develop within social contexts
- An understanding of the **subject matter and curriculum** to be taught in light of the social purposes of education
- An understanding of **teaching** in light of the content and learners to be taught, as informed by assessment and supported by a productive classroom environment

At the center of the conceptual framework in Figure 2 is a vision for practice that integrates knowledge about learners, curriculum, and teaching. The development of a vision for teaching relies on the fusion between coursework and clinical work—theory and practice—that enables teacher candidates to develop initial knowledge and skills in a meaningful way.

Two decades after it released *How People Learn*, the National Academy of Sciences released *How People Learn II*,[17] summarizing new insights into learning and development. These do not change this central conception of teaching knowledge, but they emphasize much more clearly the influences of sociocultural and motivational factors on learning. The report explains how learning is influenced by cultural, social, emotional, and physiological experiences and how motivation is fostered when all learners perceive the learning environment as a place where they belong and where their sense of agency and purpose is promoted:

> Effective instruction depends on an understanding of the complex interplay among learners' prior knowledge, experiences, motivations, interests, and language and cognitive skills; educators' own experiences and cultural influences; and the cultural, social, cognitive, and emotional characteristics of the learning environment.[18]

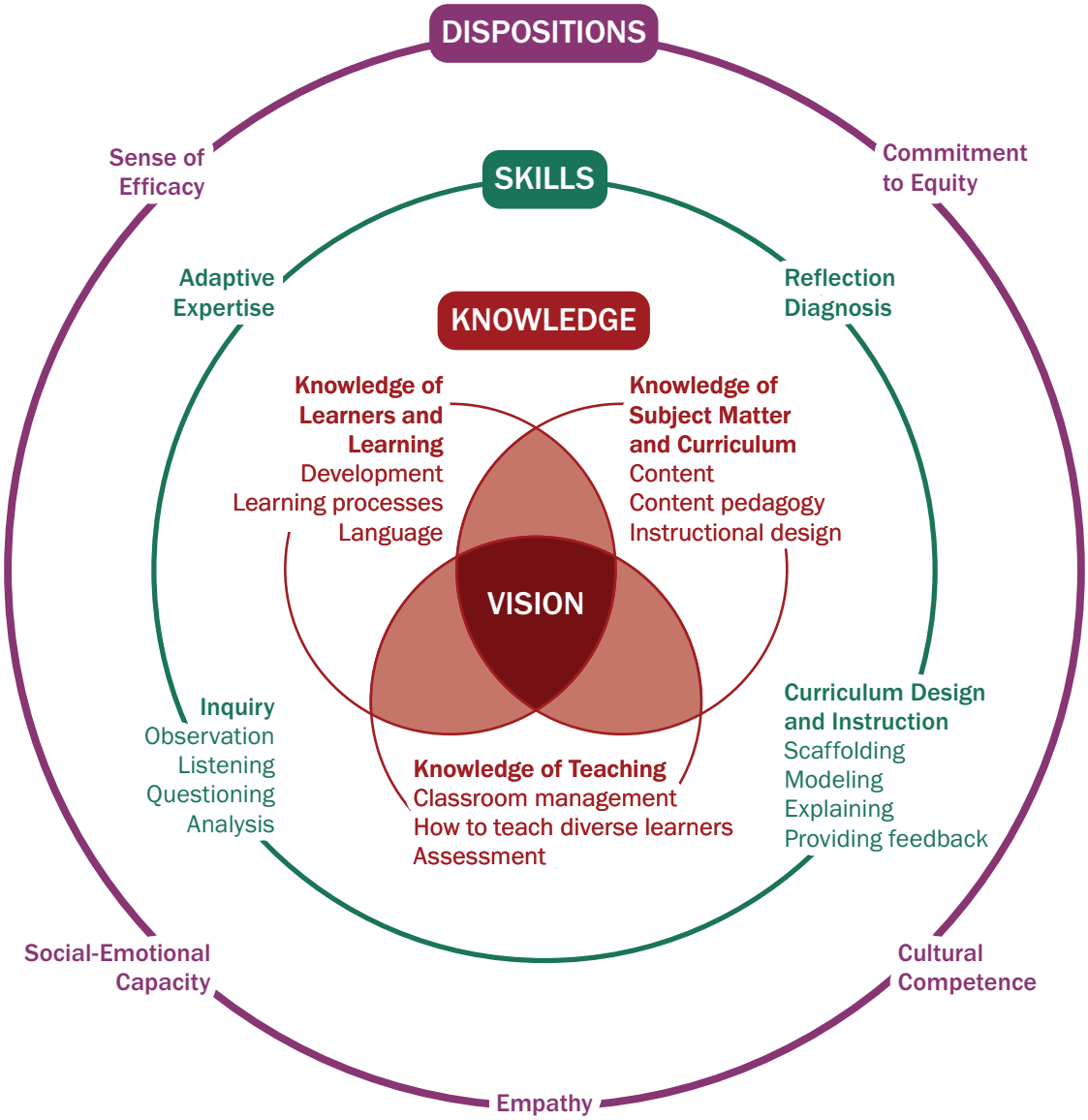
Figure 2
Framework for Teacher Education



Source: Darling-Hammond, L., & Bransford, J. (Eds.). (2005). *Preparing Teachers for a Changing World: What Teachers Should Learn and Be Able to Do*. John Wiley & Sons.

Shaping these contextual factors productively is a critical goal for educator preparation. The areas of knowledge described above must be joined with skills of curriculum design and instruction, inquiry, reflection, and diagnosis to produce the adaptive expertise that enables teachers to make the connections between children and content that are necessary for learning. And these skills must be further joined to dispositions and attitudes that support empathy, social-emotional capacity, cultural competence, and a commitment to equity in support of each child's well-being. (See Figure 3.)

Figure 3
Knowledge, Skills, and Dispositions for Teaching: The "What" of Teacher Education



Finally, while school leaders should be prepared with this same foundational grounding, there are additional capacities they need in order to create the environments in which children and educators can thrive. These include understanding how to design schools for strong relationships between and among students, educators, and families while supporting staff in infusing this knowledge into all aspects of teaching, grading, and assessment as well as into school norms and routines (including student discipline policies), student support systems, and parent involvement. A major part of the leader's repertoire is supporting ongoing inquiry and collaboration to understand children's needs and to support their welfare.

Knowledge about learners and their development in social contexts

Learning and development affect each other, and both are deeply embedded in sociocultural contexts. This means that teachers must understand and appreciate children's different experiences. In order to teach students who learn in different ways and whose prior knowledge reflects diverse cultural and linguistic traditions and experiences, teachers must understand development and the learning process deeply. The fundamental concepts that educators must understand regarding learning and development are summarized below.[19]

Learning. Understanding the **learning process** is fundamental to expert teaching. Children's prior knowledge and experiences, their cognitive strategies, and their motivation all affect their process of learning.[20] Thus, teachers need to know how to surface and build on those prior experiences, understand how children are thinking, and know how to construct tasks that are motivating. Using a "funds of knowledge" framework, educators can learn how to link unique experiences and skills from children's everyday life and culture to classroom instruction.[21] This practice can captivate children's interest and foster deeper learning.[22]

It is also helpful for teachers to understand how children coordinate and regulate many different **cognitive processes**, including memory and attention, as they are learning. They need to help children integrate new information with what they already know by developing mental models of how things work and how ideas connect. By understanding how cognitive processes operate, teachers can enable greater learning, including higher-order thinking and problem-solving, by reducing unnecessary cognitive load and by scaffolding learning in deliberate ways.

Knowing that the opportunity to make choices about the learning process supports students' **motivation**, develops their sense of agency, and ultimately affects their learning,[23] teachers can also learn to integrate the appropriate amount and kind of choice into their assignments for students. They can also learn how to construct tasks that are intrinsically motivating because they connect to students' interests, offer access to different learners and scaffolds for progress, and communicate expectancies of success.

Development. Understanding **developmental pathways and progressions** is crucial for understanding and designing effective learning environments that are optimal for each child. In addition to understanding the areas of development—social, emotional, cognitive, academic, physical, and psychological—and their interactions, teachers must understand that children develop in different domains at different times and rates. Identifying the zone of proximal development[24] for each learner in each domain is a starting point for instruction, enabling the teacher to build on what a specific child already knows in providing supports for what they are ready to learn.

Teachers need to understand and know how to support the development and **integration of social and emotional learning** with cognitive development and academic learning. Although children do not have the same starting points and do not follow identical pathways, they can all find success if educators are grounded in an understanding of how to develop foundational skills and mindsets, such as self-regulation, executive function, a sense of efficacy, and a growth mindset.[25] Skilled teachers also intentionally support the development of social skills, such as cooperation and communication, and emotional skills, including empathy and emotional recognition and regulation, by modeling these skills, providing explicit instruction on them, and infusing opportunities to practice throughout the day.[26]

Children's development depends significantly on **supportive conditions**, including positive relationships; physical, emotional, and identity safety; and a sense of belonging and purpose.[27] Educators can support these needs by creating school and classroom environments that explicitly recognize the value of each child and develop a mutually caring community. This includes addressing **social identity threats** that exist in the society at large and that can permeate schools as well. Students who have received societal or school-delivered messages that they are less capable or less worthy as a function of race, ethnicity, language background, gender, sexual orientation, economic status, disability, or other traits will often translate those views into self-perceptions of ability.

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Social identity threat can come from other students in the form of ostracism or bullying or from adults who communicate low expectations or negative views. This threat induces stress that triggers reduction in working memory and focus, leading to impaired performance.[28] Teachers need to understand how their attitudes toward students can shape their expectations and interactions with students and can support or undermine students' conditions for learning.[29] Unfortunately, there is evidence that many educators have more negative perceptions and lower expectations of Black and Latino/a students' academic ability and behavior, interacting with them less positively than with White students, which can trigger social identity threat and hinder learning.[30] Teachers can counteract social identity threat by affirming and conveying confidence in their students,[31] setting high expectations and assuring students that they can reach those expectations, and linking their funds of knowledge with classroom instruction and content.

Language. Language is the medium of instruction, and teachers need to know how to help students develop language skills of reading, writing, listening, and speaking for academic purposes. This includes the **academic language** they need to do work in school (e.g., discipline-specific vocabulary and concepts) and the ways that language is used—for example, in textbooks, essays, lab reports, or classroom discussions. It also includes the development of **reading skills and language proficiency** for those whose first language is English and those for whom it is not.[32] Given evidence that bilingualism benefits cognitive development and reading proficiency, this also includes preservation and use of the native language to the extent possible.[33]

Knowledge of subject matter and curriculum goals

Understandings of development and learning provide the foundation on which teachers learn to build successful curriculum to guide the learning process. To this foundation they add their understanding of content: Teaching in ways that enable students to learn and apply knowledge requires that teachers have a deep and flexible knowledge of subject matter so that they can represent ideas in powerful ways that connect to students' experiences, can organize a productive learning process for students who start with different levels and kinds of prior knowledge, can assess how and what students are learning, and can adapt instruction to different learning approaches.[34]

Knowledge of content combines with knowledge about learning and learners to create **pedagogical content knowledge**,[35] which is the foundation for teaching subject matter deeply so that students can transfer and use their knowledge.[36] This knowledge, which is unique to each subject area, enables teachers to integrate core concepts from the disciplines with the modes of inquiry specific to the discipline—such as scientific investigation, mathematical modeling, literary analysis, historical inquiry, or artistic performance. It allows teachers to select materials purposefully and offer explanations to provide a sense of the big ideas and how they are connected, structuring hands-on inquiries that engage students actively in using the material to make sense of how concepts build on each other and fit together. It helps them develop multiple and varied representations of key concepts that make them vivid and accessible to diverse learners, building on their different experiences.

Pedagogical content knowledge, when combined with **instructional design** knowledge, enables teachers to design, sequence, and pace appropriate activities; diagnose and respond to student learning needs with appropriate scaffolding; and integrate social, emotional, and academic skills. Constructing curriculum requires integrating knowledge about cognitive, social, and emotional processes with curricular content in ways that promote growth in students' understanding, sense of efficacy, and motivation.[37]

This stands in contrast to the century-old "factory model" view that teachers merely need some canned techniques for teaching and the ability to follow predetermined curriculum packages or textbooks, rather than the deeper understanding of learners and learning that will allow them to design classroom environments and activities, and choose or adapt useful curriculum materials, to support individual children whose pathways to learning are unique.

Knowledge about teaching

Knowledge for teaching diverse learners. Pedagogical content knowledge must be combined with knowledge of methods for teaching students who learn in different ways; who have distinctive experiences, motivations, and interests; and who start in different places in their learning. This ability begins with **pedagogical learner knowledge**: the "ways in which teachers deal rigorously and supportively with learners."[38] Tools for getting to know students and how they think and learn (including how they think about themselves as learners) need to be combined with knowledge about learning modalities, differences, and disabilities; language development; cultural contexts; and differentiation of instruction to support each learner's cognitive, social, and emotional development and learning.[39]

One aspect of this work is the use of multimodal teaching strategies that deliberately support success for students who learn in different ways—like those that are part of the Universal Design for Learning framework. Neuroscience has demonstrated that every human brain is different, and every path to learning will vary as well.[40] A critical aspect of enabling success for diverse learners without labeling, tracking, and stigma is the use of multiple modalities of engagement and expression in the classroom—and the use of multiple representations that can connect to students' different experiences and prior knowledge.

Assessment. Knowledge of **assessment** is also critical so that educators can appropriately identify what students are learning, how they are thinking, and what they are ready to learn. It is critical for educators to understand assessment as a tool to inform teaching and support learning, not

merely to assign grades.[41] The feedback educators receive from ongoing formative assessments can help them better identify what students are learning and provide information on students' zones of proximal development[42] in different domains to gauge what they are ready to learn next. Interpreting and using this information well requires a solid understanding of development, learning, content, and curriculum.

Teachers also need to learn how to understand assessment in relation to core principles of learning, such as motivation and metacognition. Thus, teachers should learn about how specific elements of assessment design—like clarity of criteria, the ways in which feedback is given, the specificity of that feedback, and opportunities to reflect and revise work in response to feedback—can affect students' motivation and their ability to develop the learning strategies, goals, and self-assessment abilities that allow them to monitor and guide their own learning.

Classroom management. To create a safe, productive environment for learning, teachers need to know about **building classroom communities**. In developmentally grounded schools, classroom management begins with knowing students well; planning and facilitating developmentally appropriate and engaging tasks; and creating an identity-safe classroom that demonstrates respect for students' experiences, engages them in co-constructing norms, and provides them with constructive roles within the classroom community.[43] Teachers also need to know how to create educative and restorative approaches to supporting behavior that provide interpersonal support and connection using reinforcing and reminding language; approach students in a nonthreatening manner; present students with problem-solving options as a means of deescalating challenging situations; and use nonpunitive, restorative consequences that allow students to make amends when needed.[44]

Skills Teachers Need to Enhance Learning and Development

The science of learning and development demonstrates that, because each child's learning journey is unique, teaching cannot be fully routinized and standardized if it is to meet students' needs. Teachers must develop **adaptive expertise**, which allows them to make nonroutine judgments about what to do based on both general and specific knowledge of learners and their paths to learning, as well as curriculum goals.[45] To create adaptive experts whose knowledge can be effectively applied in a variety of circumstances, preparation programs must teach their students the "whys" and "whens," not simply the "how-tos."

This adaptive expertise enables teachers to learn to think pedagogically, plan based on students' prior knowledge and needs, reason through dilemmas, and analyze student learning to develop appropriate curricula for diverse learners. Further, they blend theory and practice around a vision of teaching that supports empowering learning for all students. As adaptive experts, teachers need to become lifelong learners open to changing their beliefs and strategies as they incorporate new knowledge and experiences. Adaptive expertise requires a willingness to ask for and receive feedback. Being a professional involves not simply knowing the answers, but also having the skills and will to work with others in searching for new answers when needed.

This highlights the importance of **metacognition** as a critical skill for prospective teachers to develop. Teaching is a particularly complex profession because it is never routine, has multiple goals that need to be addressed at the same time, involves incredibly diverse groups of students, and demands multiple kinds of knowledge to be synthesized in a way that allows teachers to make sense of their students' worlds.[46] Given these complexities, it is imperative that teachers develop the

metacognitive ability to reflect on their practice and student learning and ask themselves what they could be doing to better serve their students. It is critical for teachers to learn to reflect on student learning in relation to their own teaching, as well as to plan and act on those reflections, in order to effectively confront the complexity of their work and pursue strategies to meet the unending puzzles associated with student learning

Inquiry skills are also important. Because the learning process is embedded in the linguistic, cultural, and developmental experiences of students, teachers must learn how to discern these experiences so they can plan in response to their students' needs and support their progression along several developmental pathways: physical, social, emotional, cognitive, linguistic, and psychological. They need tools and practices that allow them to learn about their students' different ways of learning, prior experiences and knowledge, and cultural and linguistic capital. For example, teachers need to learn how to learn about the strengths and needs of individual students through careful observation and listening, as well as through such techniques as regular check-ins and class meetings, conferencing, journaling, and classroom surveys.

Teachers also need **culturally sensitive listening and questioning skills** to use both with students and when meeting with families as authentic partners. These skills can enable teachers to learn about their students' lives and learning strategies and to create more coherent, well-reinforced learning opportunities between home and school. These, in turn, can help create environments in which students feel culturally respected and emotionally and intellectually safe.

Because teachers have multiple goals, students are many and diverse, and teaching requires that many different areas of knowledge be integrated, teachers need well-developed **observation and analytic skills** to analyze what is going on in the classroom and to make sound decisions about curriculum, instruction, assessment, and classroom management in response to the needs of the particular students they teach.

Furthermore, meeting these needs depends on knowing how to take them into account while undertaking a purposeful journey toward curriculum goals that produce deep understanding of subject matter for students. **Curriculum design skills** build on an understanding of content and instructional design translated into skill in selecting materials and developing lessons and units of instruction that can achieve worthwhile learning objectives. When teaching these lessons, teachers need skills for **scaffolding** the learning process through the choice of materials, design of tasks, and use of helpful questions and supports to guide learners.

When they are teaching, teachers need a wide range of **instructional skills** that build on effective pedagogies. These include, for example, skills for explaining concepts and modeling strategies, leading a discussion, managing collaborative group work, eliciting and interpreting students' thinking, implementing norms and routines for classroom discourse and work, checking student understanding, and providing useful feedback.[47]

Behind the scenes, teachers must also deploy **reflective and diagnostic skills** to what they see happening with student learning each day, so that they can identify and plan the next steps to support students in multiple areas of development, ranging from bolstering confidence to filling specific knowledge gaps or supporting academic, social, or emotional skills and habits. Preparing teachers who can learn *from* teaching, as well as learn *for* teaching, is one of the key challenges for teacher education.[48]

Helping teachers learn to practice in these ways requires both coursework and clinical work that, together, help teachers understand students and how they learn while also developing skills and tools to organize and manage rich learning experiences. Studies have found that teacher education programs that have a greater impact on the initial conceptions, practices, and effectiveness of new teachers are those that connect theory and practice in coherent ways.[49]

Dispositions

A key insight from the science of learning and development is that the social-emotional skills, habits, and mindsets educators bring to their work with children can either support or hinder development and learning.[50] Supportive, responsive relationships with caring adults are essential for healthy development and learning. Teachers who have the awareness, empathy, and cultural competence to understand children's experiences, needs, and behaviors can promote children's positive engagement and confidence in support of their learning. In this section, we describe the dispositions needed to effectively integrate the science of learning and development into practice.

Teachers who have the awareness, empathy, and cultural competence to understand children's experiences, needs, and behaviors can promote children's positive engagement and confidence in support of their learning.

Educator empathy and social-emotional capacity

Creating an environment in which all students are respected, nurtured, and made to feel safe depends not only on teachers' classroom management skills but also on their social-emotional skills.[51] For example, teachers who are empathic provide a model for students and communicate to students that they are seen and understood. The impact of teacher empathy as an important disposition is demonstrated by a series of experiments in which encouraging a more empathic mindset among teachers reduced implicit bias and punitive discipline while eliciting more respect from students.[52]

Furthermore, teachers' role in cultivating students' social-emotional skills is accomplished through modeling of those skills as well as through direct instruction.[53] In order to support the development of social-emotional skills in children, teachers themselves need to learn and embody skills for managing adversity, directing energy in productive ways, and interacting positively with others. This includes (1) skills for cultivating empathy and caring for all their students, particularly for recognizing and supporting students who have experienced trauma; (2) skills for affirming students' identities and academic progress in ways that support student self-confidence and self-competence; and (3) interpersonal skills to address students' needs as possible within the classroom and to draw with care and discretion on outside-of-classroom resources that are needed.[54]

Cultivating empathy. To build trust and positive relationships that reduce students' anxiety, teachers need to be able to practice empathy and view children's behaviors through the lens of child development and with an understanding of the effects of trauma. This allows teachers to

understand that problematic behaviors are typically the result of unmet needs that can be identified and addressed. Sometimes these behaviors can be traced to traumatic experiences rather than to willful defiance or disrespect.[55]

Developing empathy can transform educators' relationships with students. For example, in one experiment, middle school math teachers were provided an empathy-enhancing experience.[56] Teachers were randomly assigned to one of two groups: the "empathic mindset" group and a control group. Those assigned to the empathic mindset condition read articles about the benefits of good student–teacher relationships that explained how students' feelings and experiences can cause them to act out. The articles encouraged teachers to maintain good relationships with students, even in the face of conflict. Teachers were asked to reflect on and write about how they could understand students' experiences and sustain positive relationships even when challenges arise. Two months later, these teachers were asked to read an article about a teacher who respected her students and to write about how they show respect to their own students. In the control condition, teachers read articles about the benefits of technology-based learning and were asked to reflect on and write about how they could bring a technology-based curriculum into their classrooms. Suspension rates in the empathic mindset classrooms were halved compared with the control group classrooms, disrupting the pattern of exclusions that produce academic failure.

In addition, teachers' perceptions of their similarities with students impact their relationship with students and, in turn, affect student achievement. In one study, teachers and students completed a survey and were assigned to one of four conditions: (1) no one received feedback about commonalities, (2) students learned five things they had in common with their teacher, (3) teachers learned five things they had in common with specific students, or 4) both students and teachers learned about five commonalities. Teachers who learned that they shared commonalities with their students perceived more positive relationships, and students earned higher grades when teachers learned about their similarities to those students. The intervention was most effective in improving teachers' relationships with historically underserved Black and Latino/a students, closing the achievement gap between these student groups and White students by over 60%.[57]

Social-emotional capacities. Consistent with biological evidence that relationships impact brain development and learning, increasing evidence points to the importance of teachers' mental health and wellness for students' success.[58] Not surprisingly, high levels of teacher burnout coupled with inadequate skills to manage stress are associated with poorer student academic and behavioral outcomes.[59] Conversely, teachers' social-emotional health translates into enhanced efficacy and job satisfaction.[60] Helping educators learn stress management skills, as well as other social-emotional skills, is key to their effectiveness and to reductions in burnout and turnover in teaching. Furthermore, when educators have developed these skills, they can teach them to their students to support their success.

Among the tools available to support educators' social-emotional skills and wellness is training in mindfulness—which develops a calm attentiveness and awareness of experiences, often through attention to breathing and physical sensations, coupled with an attitude of openness and nonjudgment. There is a growing body of literature documenting the physical and mental health benefits of mindfulness practice,[61] which can increase the capacity to respond calmly and skillfully based on the needs of the current moment. In a classroom environment where there are many competing demands for attention, developing the capacity to recognize what is happening in the moment and respond calmly and flexibly contributes to teachers' adaptive expertise. Studies find that training in mindfulness can reduce teachers' stress and emotional distress; help them regulate emotions; and develop greater

social-emotional competence, an enhanced sense of self-efficacy and well-being, and improved instructional practices and emotional support for students.[62] Mindfulness-based programs that support educators in implementing positive coping mechanisms when dealing with stressors can also mitigate the impacts of chronic emotional stress, a particular job hazard in education when caring educators are continually concerned about trauma that impacts their students' lives.[63]

Cultural competence and commitment to equity

Strongly related to teachers' development of capacities like empathy are the beliefs they carry and feedback they provide to their students. As noted earlier, teachers' perceptions of students shape expectations that often predict student achievement apart from prior ability. While the vast majority of teachers enter the profession with a passion for fostering children's learning, growth, and development, implicit bias can nonetheless color how they interact with their students. Thus, educators need to proactively cultivate positive and affirming attitudes in order to create culturally sensitive and identity-safe environments.[64]

Schools foster or impede these beliefs to the extent that they group or track students in ways that convey messages about perceived ability, deliver stereotypic messages associated with group status, and emphasize ability rather than effort (e.g., "innate intelligence" vs. "hard work") in their judgments about students and their attributions of causes of success.[65]

That affirming attitudes can make a difference in outcomes is suggested by the growing number of studies finding that students of color achieve at higher levels, attend school more regularly, and feel more cared for in the classroom when they have teachers of color,[66] likely because these teachers demonstrate strong belief in their students' abilities.[67]

All teachers can convey affirming attitudes by expressing their confidence that students can learn; encouraging children to excel; and building on the individual and cultural resources they bring to the school, ranging from social knowledge of the community to mathematically rich pastimes such as chess and sports to expressive understanding of language use and popular culture.[68] Such teaching relies on a disposition toward developing classroom practices that capitalize on the funds of knowledge that are abundant in children's households and communities,[69] rather than on a deficit-based orientation.

Teachers' affirmation that students are seen as competent and valued also mitigates the effects of social identity threat or stereotype threat, which undermine performance. Many studies have shown that when teachers demonstrate their belief in student ability and provide feedback and supports clearly aimed at improvement, performance on tests, grades, and other academic measures improve significantly in ways that are frequently maintained over time.[70] Teachers who respect cultural differences are more apt to see all students as capable learners and to offset stereotype threat by conveying their faith in students' abilities.

Strategies that convey respect and concern for students—the basis of culturally responsive pedagogy—create a foundation for meaningful relationships and positive academic results.[71] Practices and dispositions associated with culturally responsive pedagogy include (1) recognizing students' culturally grounded experiences as a foundation on which to build knowledge, (2) cultural competency in interacting with students and families, (3) an ethic of deep care and affirming views of students, and (4) a critical consciousness and sense of efficacy about learning and creating equity-oriented changes in the status quo that is consciously transmitted to students.[72]

Sense of efficacy

All of the knowledge, skills, and dispositions that are associated with teacher effectiveness are, equally, related to teachers' sense of efficacy. This sense of efficacy refers to the beliefs individuals hold about their ability to successfully carry out a specific course of action.[73] Teachers' sense of efficacy affects their investment of effort, their enthusiasm for teaching, their classroom processes, and students' experiences.[74] Higher teacher efficacy is associated with more positive student–teacher relationships as well as greater student motivation and achievement.[75]

Teachers are likely to feel a greater sense of efficacy when they have a strong professional learning community, which, in turn, strengthens their knowledge and skills for teaching.[76] Preparation to teach also strengthens efficacy. Teachers who complete preparation before they enter the field feel more efficacious and are more likely to remain in teaching[77] and produce higher student achievement.[78] Further, attrition rates of new teachers who have had comprehensive preservice preparation are half as much as those of beginning teachers who have not had strong clinical experiences along with coursework in learning, development, and curriculum.[79] Many of these features—including the study of curriculum materials and carefully supervised clinical practice—also distinguish programs whose graduates are more effective in supporting student learning gains.[80]

In-service training that improves classroom environments, such as that associated with some social and emotional learning programs, has also been found to promote greater self-efficacy, more positive attitudes toward teaching, and teaching practices that are supportive of students,[81] as well as positive academic and behavioral outcomes for students.[82]

Additional Knowledge for School Leaders

In order to support practice aligned with the science of learning and development, leader preparation is as important as teacher preparation. School principals and other administrators must understand child development and learning in all the ways described above, *and* they must understand organizational development if they are to ensure that schools infuse this knowledge into school design, teaching, teacher development, school discipline, and parent involvement. Leaders must be able to design schools and systems that integrate the development of cognitive, social, and emotional abilities into student learning.[83]

For school leaders to establish organizations based on the science of learning and development that build the supportive environment students need to thrive, they must know and value the pedagogical practices that support this type of learning in both children and adults. Then, they must employ an instructional leadership approach that orients teacher learning toward improving these practices, while also employing collective leadership practices that support collaborative buy-in from teachers, parents, and many other key stakeholders.[84]

Instructional leadership does not simply refer to identifying instruction as a key component of learning, but instead refers to schools where school leaders help faculty identify and adopt practices that are productive for the school's students; support each other in deepening these practices; evaluate and coordinate how curricula and assessments align with these practices; apply professional development resources to support these practices; and regularly monitor teaching practices and student progress as part of continuous improvement cycles.[85]

In addition to enabling the use of practices that support cognitive, social, and emotional learning, leaders must be able to create a positive environment that facilitates the use of educative and restorative behavioral supports that prioritize students' participation in the school community. Leaders also need to be aware of the needs of students who may be marginalized or living under adverse conditions and have the skills to organize the additional supports they need within the school and the surrounding community.

Just as supportive, responsive relationships are essential for children's learning, they are also critical conditions for teachers' learning.[86] Establishing trustful, collaborative relationships among staff is a critical component in making the transformation to whole child education. Relational trust among teachers, parents, and school leaders is a key resource for schools that predicts the likelihood of gains in achievement and other student outcomes when instructional expertise is also present.[87]

Principals and school leaders need to know how they can nurture relational trust among educational staff through a range of strategies, including (1) creating time and space for staff collaboration focused on curriculum planning and improvement, (2) supporting teachers' growth and development through asset-based feedback and learning systems, (3) distributing leadership for many functions throughout the school, and (4) involving staff in decision-making.[88] The practice of distributed or shared leadership, which encourages teachers to take an active role in constructing and implementing the school's approach to its work, is associated with leader effectiveness as well as with teacher satisfaction and retention.[89] Engaging teachers in leadership roles with greater responsibility increases buy-in while also strengthening the professional community at the school.[90]

These practices also support the development of collective efficacy among faculty. When teachers believe they can work together to overcome challenges and achieve goals, they are more likely to be effective at improving student achievement.[91] Large-scale studies have found that improvements in teachers' effectiveness over time are related to the type of school they work in: Those in more supportive and collegial professional environments become more effective more rapidly than their peers in schools with less collaborative professional environments.[92] These environments are characterized by collaboration among teachers, the availability of time and resources for teachers to improve their instructional abilities, and teacher evaluation that provides meaningful feedback.

Principals can learn to build trusting and collaborative relationships focused on the improvement of practice through professional learning communities that support both teacher and student learning.[93] The key elements of productive learning communities are that they focus on issues central to teachers' practice and that discussions dig beyond the surface level, toward "core suppositions, assumptions, and principles."[94] Leaders who orient school goals toward deeper learning for students model these practices in how they organize teacher learning and create opportunities to sustain this learning both formally and informally.

To implement useful professional learning opportunities, school leaders should be familiar with research that suggests that practitioners learn best in continuous, guided professional learning that contextualizes concepts within their needs and experience,[95] and that provides practitioners with opportunities that emphasize active engagement, assessment, observation, and reflection, rather than abstract discussion.[96]

Thoughtful leadership focuses on more than just instructional practices. Leaders who understand how teacher wellness impacts teacher retention and burnout[97] prioritize policies that safeguard teaching time and allocate resources to support teachers in managing the impacts of stress. These organizational resources can include providing mindfulness or other wellness-oriented resources, protecting teaching time, creating consistent time for teachers to meet collaboratively in teams that allow teachers to use one another as resources, and empowering teachers to hold more authority in decision-making.[98]

Leaders who understand how teacher wellness impacts teacher retention and burnout prioritize policies that safeguard teaching time and allocate resources to support teachers in managing the impacts of stress.

School leadership knowledge includes the ability to redesign schools in support of strong relationships by, for example, introducing looping or advisory systems and creating teaching teams that share students.[99] It also includes the ability to manage the changes needed to improve conditions for children and adults, to connect to communities, and to organize adult learning toward these ends.[100]

In sum, to build the supportive environment that students and educators need in order to thrive, school leaders need to know how to design school structures for effective caring, intentional professional learning communities, and authentic collective leadership. Modeling practices that are learner-centered and that scaffold teachers in acquiring the same skills that students need facilitates an environment in which teachers experience these supports and in turn provide them to their students.

How Educators Can Develop the Necessary Knowledge, Skills, and Dispositions

In this section, we tackle the nontrivial question of *how* educators can acquire the knowledge, skills, and dispositions necessary to enact the science of learning and development in practice. The previous section addressed what teachers need to know and do to support student learning and what kinds of learning opportunities are helpful in developing these practices.[101] Yet, even with these foundational advances, educator preparation that enables the practices required by a holistic conception of student learning and development is not yet common in the field, any more than such learning is common in pre-k–12 schools. Just as the call to utilize the science of learning and development to shape schoolwide practice places significant new demands upon educators and schools, so too does the need for educators to learn how to implement such practices place significant new demands upon educator preparation and professional development.

These demands come, in part, from the breadth and depth of the content educators must master, but also from the necessity of providing them with models and experiences of the sort of teaching and learning they will be expected to enact in schools. Building on what we know from the science of learning and development calls for a set of sophisticated practices that are more personalized and student-centered; more focused on deep, transferable learning; and more concerned with equity than practices that are widely found in American schools.

Challenges of Learning to Teach for Deeper Learning and Equity

There are three well-known challenges of learning to teach that are more pronounced when the kind of teaching needed to promote deeper learning is more complex than the norm:

1. **The challenge of the apprenticeship of observation**.[102] One of the most significant challenges that teachers face in learning to teach is that they enter teaching having already had years of experience in schools as students. This prior school experience can provide motivation and models for teachers, but it can also create some important limitations. Students in schools see only the immediate, surface-level actions of teachers, rather than any of the thought, preparation, reflection, and intentions that inform those actions. Thus, these experiences can lead to misconceptions or unrealistic expectations about the work of teaching—for example, that it is merely a matter of mastering a few routines or that good teaching boils down to enthusiastic presentation or the simple "transfer" of information.[103]

   Teachers' school experiences may also leave them with an unreflective or incomplete understanding of issues of race and class in education and without the tools needed to design engaging and developmentally appropriate instruction for all students. Finally, since teaching practice thoroughly informed by the science of learning and development is still uncommon in k–12 schools, teachers may not have had the opportunity even to see it as students, which may potentially contribute to their misconceptions about what they should learn to do.

2. **The challenge of enactment.**[104] New educators also face the challenges of learning to put their ideas into practice and of solving the many problems of practice that arise, and they do so with many more clients at a time than other professionals. Preservice teachers must

learn to put their knowledge into plans for practice; weigh difficult decisions about what will work for which children under what circumstances; and then enact their plans in the classroom using a range of techniques to organize children's actions, gain their attention, inform their thinking, and support them as they engage in the various tasks the teacher has designed. While some might describe this kind of learning as being able to "apply" knowledge to practice, separating theory from practice creates a false dichotomy. Indeed, teaching is a prime example of a profession in which theory is embedded in and inseparable from the practice.[105] Learning how to think and act in these kinds of professional ways requires far more than "book learning."

3. **The challenge of complexity.**[106] Teaching is an incredibly complex and demanding task, featuring an array of activities and judgments that teachers must juggle simultaneously, pursuing multiple goals with both individuals and groups of students, all within the context of immediate lessons and long-term learning goals.[107] Students come to class with needs, challenges, questions, and dilemmas that are different to begin with and that evolve over time. Teaching these students requires attending to both content and social and intellectual development in ways that address the needs of individual students, groups of students, and the whole class in real time. In doing all this, teachers integrate their knowledge of subject matter and pedagogy; child development and social and emotional learning; and the interactions of students' strengths, needs, cultures, backgrounds, and prior experiences, all in ways that support learning for every student.

Designing Learning Experiences for Adults

In order to design learning opportunities that are effective and useful for educators, an understanding of adult learning theory is essential. Adults bring with them substantial prior knowledge and interpreted experience, and they may have fixed ideas or preconceptions that influence their receptivity to new information. This knowledge has been shaped by the culture and context within which adults live and work; social institutions and structures define the learning experience to a large extent.[108]

Andragogy, a theoretical framework for adult learning, emphasizes both the prior knowledge and experiences adults bring to learning and their motivations to expand those experiences.[109] Its principles suggest that adult learners need to know why they should learn, see how knowledge is aligned with their values and goals, tap into their well of experiences to engage and drive meaningful learning, feel in control of their learning, and engage in task-oriented learning that reflects their experiences in the real world. Adult learners can be more successfully engaged when they know how the learning will take place, what learning will occur, and how it relates to their own professional purposes.[110] For these reasons, it is useful to involve educators in planning for professional development.

Adult learning theory notes that, as is true for students of all ages, applying learning to real-world situations enables learners to make meaning through direct experience. Early work on experiential learning described the cyclical nature of learning in four stages: (1) concrete experience that involves active hands-on engagement to learn by doing; (2) reflective observation that entails observation and analysis; (3) abstract conceptualization that encourages critical thinking and making connections to the real world; and (4) active experimentation that applies knowledge, furthering experiential learning.[111] Specific strategies are recommended for each stage of the

cycle—for example, simulations and case studies for concrete experiences, discussions and small groups for observation and reflection, content sharing during abstract conceptualization, and internships and lab experiences for active experimentation.

"Transformational" adult learning that dramatically changes how individuals see the world and act within it takes place when earlier experiences or views are seen in a different light with new meaning.[112] Perspective transformation—the process by which one's perspective of oneself and the world shifts with greater understanding of the perspectives of others—is the vital first step in fostering personal and social change. It happens when faced with a dilemma for which previous perspectives or practices are inadequate. Looking at the world through the eyes of someone else, or perspective taking, is the mechanism by which transformation occurs. In teacher education, for example, it is crucial that participants understand the perspectives and experiences of their students, as well as the impacts of those experiences—including those that have been traumatic—on their development and learning.

To support this process, the transformative classroom environment should be safe, inclusive and open, and respectful of candidates and their cultures, featuring multiple modes of acquiring and presenting knowledge. Classroom environments are open when instructors are willing, themselves, to be reflective. Effective participation in transformative learning discourse requires emotional maturity, awareness, empathy, and control, as well as being aware of and managing one's emotions, motivating oneself, recognizing emotions in others, and handling relationships.[113] These features are equally as important when adults are the learners as they are when children are being taught. As we illustrate below, these are features of impactful educator preparation and professional development experiences.

Key Strategies and Practices for Educator Preparation

The problems of the apprenticeship of observation, of complexity, and of enactment, along with the necessity of attending to the needs of adult learners, create parameters for prospective teachers' learning that should guide the design of effective programs. As described below, program design should center around a coherent vision of whole child development, learning, and teaching that guides pedagogical alignment between the ways in which educator candidates and their future students are supported and taught. This argues for a developmental approach to the development of educators (just as educators use with their students) that occurs experientially in contexts offering well-supported clinical experiences tightly linked to coursework that integrates theory and practice.

Key Strategies for Educator Preparation Program Design

Pedagogical alignment

A critical program strategy for enabling candidates to learn sophisticated approaches to teaching that extend beyond their previous school experience is the creation of **pedagogical alignment around a coherent vision** of whole child development, learning, and teaching. In both their coursework and the clinical work settings, new teachers and school leaders should experience the very kinds of teaching strategies they are expected to develop for the pupils they work with. Prospective teachers and leaders need to learn in the ways that they are expected to practice so that they have a deep personal understanding of the pedagogies and strategies they will use and rich models of practice on which to draw. Recent research on leading educator preparation programs[114] illustrates how pedagogical alignment around a vision of learning for children and adults is:

Prospective teachers and leaders need to learn in the ways that they are expected to practice so that they have a deep personal understanding of the pedagogies and strategies they will use and rich models of practice on which to draw.

- developmentally grounded and personalized to meet the needs of individual students;
- contextualized in real-world settings;
- applied in ways that can be transferred to new situations;
- located in productive communities of practice that reinforce the learning process; and
- explicitly focused on achieving equity for students.

In order for candidates to develop more robust understandings, it is important for them not only to study individual ideas but to see how they interact to produce a coherent vision of learning related to a coherent vision of teaching and schooling. What educators need in order to do their jobs well is tightly aligned to the capacities they are being asked to develop in their students: the ability to think critically and solve problems; apply knowledge to novel situations; engage and communicate well with others; and manage their work, and their classrooms, effectively. Thus, learning *about* pedagogy derived from the science of learning and development also means learning *with* and *through* such pedagogy. Enactment of the science of learning and development in practice becomes both the goal and the guide for teacher educators.

Well-designed clinical experiences

A corollary of this pedagogical alignment is **extensive engagement in clinical practice that instantiates the developmentally grounded practices educators need to learn**. In programs that prepare educators to teach and lead in new ways, educators experience those practices for themselves. Educator preparation uses and models student-centered pedagogies in courses and provides educators with opportunities to put these pedagogies into action in their clinical work; reflect on the results; and acquire a deep, flexible, firsthand understanding of learning and development. Extended student teaching or residency placements are carefully selected and designed to allow candidates to learn to teach or lead in settings that illustrate the science-based practices they are learning about in their courses. These settings provide opportunities for prospective educators to observe knowledgeable mentors who provide modeling, feedback, and coaching. This practical experience allows candidates to relate work in the classroom to coursework and to reflect on how specific practices influence student responses and learning.

Just as teaching hospitals in medicine were designed to bridge the divide between theory and practice by ensuring a place where best practices could be observed and learned, so strong school–university partnerships are critical to creating clinical placements that are consonant with the theoretical learning candidates are undertaking. In Finland, for example, all teachers are trained in model schools or partner schools that are part of the regular public school system but are connected to universities, which select the highly expert mentor teachers who work in these schools and include them as clinical members of the university faculty, while professors teach many of the courses on-site. Faculty of the partner schools and universities work closely together designing strategies, modeling practices, and researching their effects.[115]

In the United States, many programs have established what are often called professional development school partnerships as a means of creating sites where best practices can be developed, observed, and studied, while providing opportunities for clinical learning for student teachers or residents. At these sites, well-researched strategies are enacted in practice and candidates have access to a robust community of professionals working on these issues. Ideally, such partnerships avoid the frequent incongruity that can occur between teacher education programs and the schools at which their student teachers spend time. Called the "two-worlds pitfall," this situation may leave prospective teachers unable to overcome the disconnect between the ideas about teaching and learning espoused in their program and those they encounter in the classroom.[116]

These relationships can, and should, extend beyond school walls, as researchers have found that prospective teachers may form a shallow impression of their students if they work only in the school setting.[117] Programs that enable student teachers to be involved in the community more broadly provide them with a deeper understanding of their students' and families' lives outside of school and offer opportunities to come to know their students well so as to better draw on their experiences and meet their needs.[118]

A developmental approach to the development of educators

Finally, educator program design should take a **developmental approach to the development of educators**, consciously supporting educators to go through the stages that eventually allow them to become increasingly expert. Just as children go through stages of development as they learn in various domains, so do teachers—from a focus on self to a focus on the student; from unexamined assumptions about teaching acquired when they were students to a thoughtful set of perspectives

about teaching acquired from professional knowledge and inquiry into many students' experiences; from attention to their own acts of teaching to attention to their students' processes of learning. With useful experience and guidance, teachers grow increasingly adept at understanding learning, teaching, and their students. Teachers develop the adaptive expertise that enables them to think, analyze, and act effectively in response to their contexts and their students' needs and to make productive decisions when many variables are in play. Well-designed, impactful experiences can allow these developmental processes to unfold more quickly and fully than might occur without this support.

To encourage adaptive expertise, teacher educators should promote candidates' ability to manage the classroom efficiently and their ability to innovate.[119] It is important to develop novices' proficiency in basic classroom functions so that they can get beyond classroom management to the important work of promoting learning. Developing proficiency requires opportunities to practice a skill, get feedback, reflect, and practice again, something that is increasingly part of teacher preparation programs that tie clinical experiences to students' learning from the very beginning of the program, rather than attaching student teaching as a dollop at the end of several years of coursework.

A key element in freeing up people's capacities to learn new skills is to reduce unnecessary cognitive load that consumes mental space needed for new learning (which constitutes, in turn, what is called "germane load"). Several strategies to reduce extraneous cognitive load and optimize germane load can be drawn from the training of health professionals. For example, extraneous load can be reduced by using open-ended tasks (e.g., rather than finding the best solution, find as many solutions as possible), teaching in multiple modalities so that candidates can learn in the ways that are easiest for them, and using worked examples (e.g., in the teaching setting, start by critiquing an already developed curriculum plan, rather than developing a curriculum from scratch).[120]

If candidates are focused on accomplishing learning goals with students in practice, rather than memorizing theories or practicing decontextualized skills, they will begin to see the complexities of teaching more effectively. Within this broader conception of goal-focused work, cognitive load can be managed by sequencing learning tasks from simple to complex (e.g., start by teaching part of a lesson, rather than the entire lesson; study the learning of a single child), and working from lower- to higher-fidelity environments (e.g., working with a small group of students in the classroom while building up to teaching the whole class; teaching individual lessons while working up to teaching an entire unit).

Germane load can be enhanced by varying the complexity of tasks as skills are mastered (e.g., engage in specific teaching practices with students with different learning needs) and by evoking self-explanation (e.g., prompting teachers to explain how a particular instructional approach facilitates particular students' learning), sensitizing them to the learning process and the importance of each child's developmental trajectory and needs.[121]

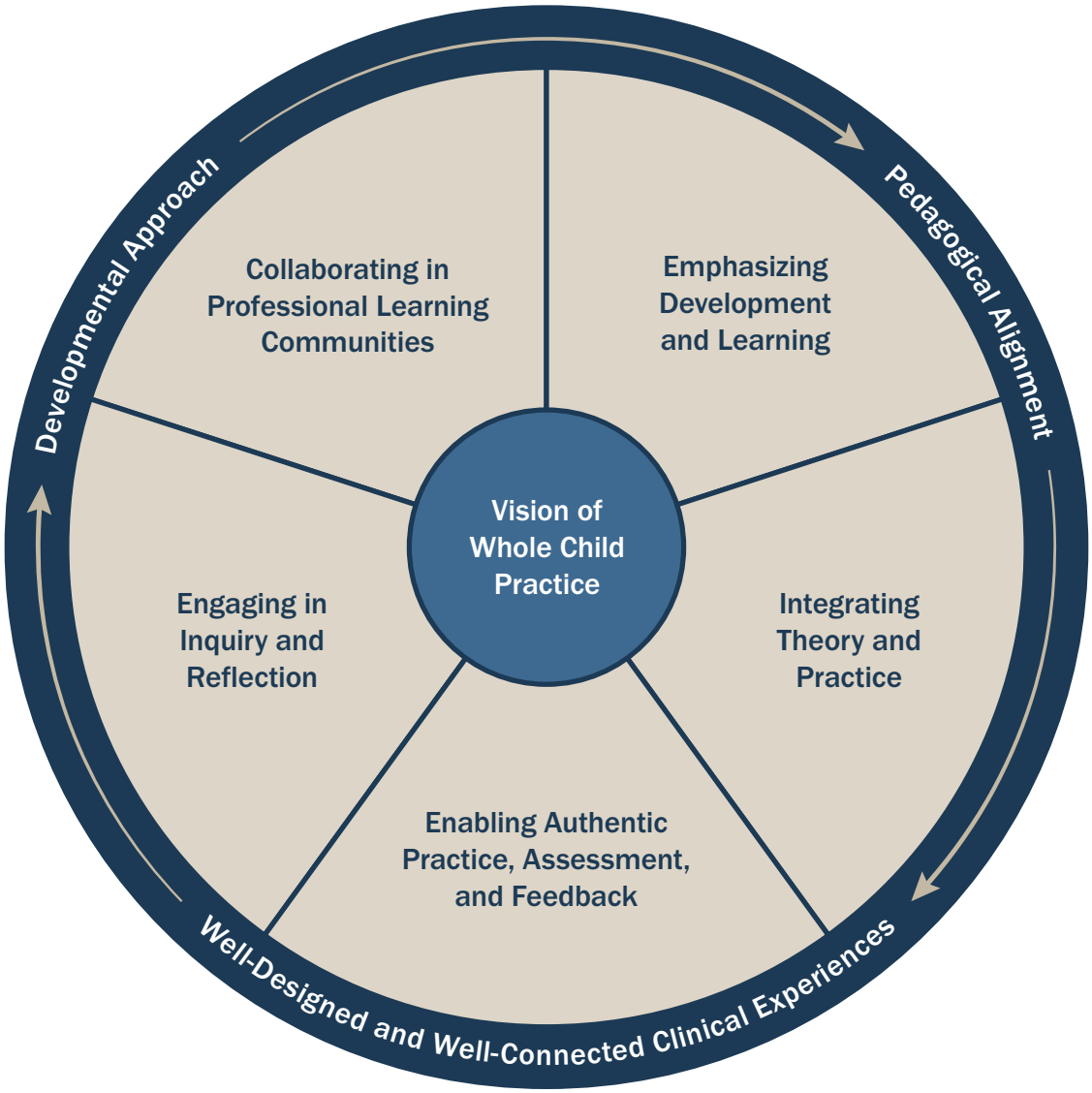
Studies have shown that, with the right set of learning experiences, new teachers can develop more expert practices much sooner and more fully than earlier thought.[122] These findings parallel recent findings in cognitive development showing that, given well-chosen tasks with appropriate scaffolding and supportive learning environments, children can learn much more than may have been anticipated by biologically based theories of stage development.

Key Practices for Educator Preparation

These overarching strategies support a set of educator preparation practices research has shown make a strong difference in the capacities of educators. As shown in Figure 4, these include:

- anchoring candidate learning in the study of human development and learning;
- integrating theory and practice;
- providing opportunities for authentic practice, assessment, feedback, and reflection;
- engaging in inquiry and analysis; and
- collaborating in professional learning communities.

Figure 4
The "How" of Teacher Education



Anchoring candidate learning in the study of human development and learning

If one views the fundamental goal of education as developing the social, emotional, cognitive, and moral and ethical capacities of each young person, then deep understanding of human development and learning—in all its diversity—is the foundation and guide for the use of all other knowledge about teaching.

If one views the fundamental goal of education as developing the social, emotional, cognitive, and moral and ethical capacities of each young person, then deep understanding of human development and learning—in all its diversity—is the foundation and guide for the use of all other knowledge about teaching. Without these understandings, the study of curriculum or teaching methods is little more than a set of rudderless techniques that comprise a bag of tricks. Educator preparation programs vary widely in the extent to which they emphasize learning about child and adolescent development and learning. According to a report commissioned by the National Council for the Accreditation of Teacher Education (NCATE), "Most educators … have not been prepared to apply knowledge of child and adolescent development and learning and are thus not sufficiently able to provide developmentally oriented instruction."[123] In many states, alternative certification programs that provide fast-track pathways to the classroom do not offer courses in child development. In some states that have cut back on training requirements, even traditional programs lack such courses. In other cases, development is taught as part of a class in educational psychology that focuses on textbook principles not directly tied to what children and teachers do in the classroom.

The NCATE report suggests that teacher education programs should not only provide more formal opportunities to learn about child development in preservice coursework, but also make sure that candidates' classroom experiences, from observations to student teaching, are organized in a way that allows candidates to reflect on and apply this approach in practice. One example is offered by Southern Connecticut State University, which—in partnership with the developmentally grounded Comer School Development Program—recently transformed its approach. The college replaced courses in educational psychology that present abstract information about development and learning with courses on child or adolescent development that are designed to inform teaching decisions and are conducted in conjunction with fieldwork that makes that knowledge base vivid and applicable to classroom practice.[124]

It is also important to connect learning about development to concrete practices that can be used to support child development in the classroom. Preparation programs can incorporate lessons from the many in-service programs that train educators to support social and emotional learning and that have been found effective in improving student behavior, attachment to school, achievement, and attainment.[125] These in-service programs typically provide curriculum materials for teachers to use in offering lessons on such strategies as emotional awareness and expression, self-regulation, empathy, problem-solving, and conflict resolution, and they offer guidance in how to enact these lessons, as well as, in some cases, coaching and peer supports.

In reviews of practice across preparation programs, the following recommendations are common:

- Teacher preparation curricula should integrate developmental science principles throughout all courses so that candidates can learn principles of development as they apply to learning, classroom management, curriculum, teaching methods, and other areas.
- Course content should be combined with practical applications, through supervised student teaching and mentoring, as well as classroom video examples, role-plays, lesson and unit planning, child study, and family engagement.
- For their student teaching experiences, candidates should be placed in classrooms with teachers who understand and implement an integrated approach to social, emotional, and academic development and learning.
- Faculties of education should hire personnel with expertise in development and learning domains and provide professional development to other faculty so they can infuse the science of learning and development into preservice teacher and principal education.
- Licensing and accreditation systems should focus more on teachers' learning opportunities and capacity to support child development and learning by moving from abstract theory to direct application tied to practice so that when teachers enter the classroom, they are well prepared to understand and teach children effectively.[126]

Integrating theory and practice

Scaffolding teachers' performance to reach greater mastery also requires skillfully integrating clinical experience with coursework, which allows teachers to learn and practice ever more sophisticated applications of knowledge and skill.

Modeling practice. In impactful programs, instructors, supervisors, and cooperating teachers model practices they expect candidates to use, name them, explain why they are powerful, and indicate how they can be applied. For example, in the San Francisco Teacher Residency program, operated in collaboration with Stanford University and the University of San Francisco, candidates learning to teach English learners experience a class taught in an unfamiliar language, along with the strategies they can use to make the content and the language increasingly accessible. Then they more fully develop those pedagogies in both their university-based classroom and in the school classrooms where they are simultaneously apprenticing.

At the University of Colorado, Denver, faculty engage candidates in the kinds of learning activities they want them to be able to use, explaining how they design lessons and organize groups to meet their learning objectives, thus allowing candidates to understand their instruction and transfer it to their clinical experiences. Similarly, Montclair State University instructors engage candidates in the sorts of deeper learning experiences they want to see in pre-k–12 classrooms, continually making the implicit explicit and encouraging reflection so candidates can understand the moves and decisions that produce this kind of teaching. At Bank Street College, candidates take up real-world mathematics problems in groups, collaboratively solving them and then sharing their solution strategies with others as they learn to transfer these teaching strategies to their own classrooms, enabling their own students to unpack misconceptions and deeply understand the mathematics.[127]

Integrating coursework and clinical work. Additionally, integrating theory and practice simultaneously, while reflecting on the results and refining next attempts, is critically important for solving the challenges of enactment and gradually dealing with the challenges of complexity.[128] Teacher education programs that incorporate classroom teaching throughout the learning experience (rather than saving it as a culminating project at the program's end) produce stronger knowledge and more effective practice.[129]

Providing theoretical knowledge along with the opportunity for hands-on inquiry is more effective than either alone.[130] Programs that integrate coursework and clinical work design both around research-based methods for teaching, which are explored in fieldwork experiences as well as in readings and discussions, engaging in intentional integration that enables candidates to understand the practical relevance of theory and how to theorize practice.[131] To support these integrated field experiences, effective programs establish and maintain productive partnerships with schools in which teacher candidates can experience teaching practice aligned with learning theory under the guidance of carefully selected and trained mentor teachers and with the support of faculty supervisors.

Candidates can develop and apply knowledge in practice through learning opportunities that are coordinated between their teacher education courses and clinical settings. These often include class assignments involving observation and analysis of teaching and student responses, as well as the structured planning and implementation of instructional strategies. When combined with time to reflect on teaching outcomes, these activities support teacher candidates' metacognition that leads to adaptive expertise. One example comes from High Tech High in San Diego, which runs a teacher preparation program for its own network schools and participating district schools in which candidates experience yearlong clinical placements alongside their coursework—both of which are grounded in project-based learning. A common course assignment, called Put It to Practice, allows teacher candidates to learn a new concept or practice in a course from faculty, try it in class soon after, and then return to reflect on the results with their teacher education colleagues.[132]

Developing content pedagogy. Content pedagogy courses offer another opportunity for the application of knowledge to practice, while also providing teachers with the skills to create learning experiences that enable their own students to apply and transfer content knowledge to novel and complex problems. Combining content knowledge and pedagogical knowledge has already been described as a way of supporting higher-order thinking and transfer; teachers who learn to work with the core concepts of their disciplines give students the tools to apply practices of inquiry and ways of reasoning, conceptual frameworks, underlying structures, and fundamental knowledge in those disciplines, opening up new ways of seeing the world and building understanding.[133]

For example, Stanford University offers a three-course curriculum and instruction sequence, with content-specific pedagogical training provided by instructors who were themselves expert classroom teachers in their disciplines. This course sequence starts with essential questions about the "why" of teaching the discipline and then moves on to the "how," from lesson planning to larger curriculum units, culminating in a performance assessment in which candidates plan and teach a unit, collecting and analyzing evidence of student learning.[134] These content-specific courses introduce candidates to the theories and pedagogical approaches that will help them create challenging learning experiences that help students engage in critical thinking and inquiry.

Content-specific methods also require candidates to examine students' developmental needs in subject-specific contexts, giving teachers the opportunity to apply learning from across their preparation experiences.

A number of successful teacher preparation programs use a common framework for curriculum design—the Understanding by Design (UbD) framework.[135] In this framework, teachers develop a design mindset as they start with the selection of goals and then design curriculum to attain those goals with their particular students in mind. UbD works backward from what students should know and be able to do in a particular subject to help teachers think, first, about curriculum goals; then about rich assessments that represent accomplishment of those goals; and then about a process of formative assessments and teaching and learning activities that lead students to be able to meet those goals. This process requires teacher candidates to understand learners' prior experiences and utilize their knowledge of child development to work backward from rigorous goals that are appropriate for their students. The UbD framework models inquiry and the application of knowledge of content, self, and students—all of which are key elements of adaptive expertise.

Learning from cases. Application is not limited to student teaching, which, while highly beneficial, does not give prospective teachers experience managing every classroom problem they might encounter. As in medicine, law, and other professions, case methods provide another useful link between theory and practice that allows for the exploration of theories and dilemmas as they occur in real classrooms. Analyzing cases can help candidates develop the expert thinking and reasoning skills expert teachers need, while surfacing some of the more challenging problems teachers face. They help "students move from an initially simplistic explanation of a situation to a more sophisticated, theory-based explanation."[136] In order for case methods to be effective, they should be well connected to central theories and broader underlying principles of practice.

Providing opportunities for authentic practice, assessment, feedback, and reflection

Human beings learn in large part from acting and reflecting on the results of their actions. Learning is accelerated by thoughtful feedback that recognizes strengths and identifies areas for next steps. This is as true for teachers as it is for students. Many effective programs use a teaching and learning inquiry circle as a means for developing reflective practice, framing teaching as a cycle of (1) planning, (2) teaching, (3) monitoring student learning and adjusting practice, and (4) reflecting on and developing next steps. In the Urban Teacher Education Program at the University of Colorado, Denver, university-based faculty, site supervisors, site professors, and clinical teachers in the partner schools all use this approach to guide candidates' teaching experiences, building feedback and reflection consistently into their preparation.

Effective preparation programs use a wide range of authentic assessments that allow for the application of skills and knowledge and offer opportunities for candidates to bring together theory and practice to demonstrate their learning. These include regular informal and formal evaluations of student teaching and other demonstrations of skills, as well as culminating assessments, such as capstone portfolios. These portfolios typically include video and analyses of teaching and student learning illustrating how candidates address student needs as well as the demands of the curriculum. It is critically important that these assessments, along with the standards and rubrics used to evaluate teaching performances, are grounded in the science of learning and development, recognizing that teachers' actions must respond thoughtfully to students rather than marching through standardized procedures and techniques without regard to children's

experiences and needs. Fortunately, teaching standards exist that can help leverage this kind of instruction. In contrast to mechanistic views of teaching embedded in some state and local teacher evaluation systems, the research-based professional standards developed by the National Board for Professional Teaching Standards and the companion standards for beginning teachers developed by the Interstate New Teacher Support and Assessment Consortium (InTASC) support a view of teaching as complex and responsive to students' developmental and learning pathways.

By examining teaching in the light of learning, these standards—and their associated performance assessments, which include teacher plans, classroom video, evidence of student learning, and commentaries describing why specific decisions were made—define teaching effectiveness as responsive to students' distinctive backgrounds, experiences, and learning needs. Studies have found that these assessment processes are in fact related to teacher effectiveness[137] and stimulate teacher learning.[138]

These kinds of assessments can help develop adaptive expertise by helping teachers learn to attend to students' thinking and development and to reflect productively on the relationship between teaching decisions and student learning and behavior.[139] Performance tasks and portfolios of teaching measured against shared standards with opportunities for feedback provide a structured means of reflecting on and documenting learning experiences. For example, at Alverno College, long known for the use of authentic assessments for evaluating student abilities, candidates complete a series of performance assessments throughout their coursework and fieldwork, demonstrating how they analyze student development and learning, plan and implement teaching, and evaluate the outcomes to determine next steps. This work is evaluated in relation to the InTASC standards, which also guide the portfolios of their practice, which candidates assemble and are interviewed about at several junctures. These demonstrate whether they have developed the dispositions and mindsets teachers need to help all students develop their full potential.

Similar performance assessments have recently been developed for administrators in several states, examining how principals are able to analyze instruction and support teacher learning, as well as assess school practices and outcomes and design change processes. In California, for example, prospective principals must demonstrate through their work in schools how they can facilitate communities of practice, support teacher growth, and analyze data to inform school improvement and promote equity.[140] The criteria on which these performances are evaluated incorporate knowledge about student learning and development across social, emotional, and cognitive domains, as reflected in the California teaching standards and administrative standards, and knowledge about teacher development to support student development.

Engaging in inquiry and analysis

Inquiry strategies guide reflection and application, preparing candidates to ask productive questions when they encounter novel teaching challenges in different schools and community contexts, while modeling inquiry-based approaches candidates can employ with their own students. Practitioner inquiry can be used to help student teachers become more reflective and analytic, teaching them to construct knowledge for themselves and allowing them to better understand the vast network of social conditions that shape their students' lives. Action research, for example, can support educators in developing a disposition toward reflective, analytic thinking, along with the important skills of data collection, observation, analysis, and reflection.

Inquiring through autobiography. Many programs have incorporated the idea that, before prospective teachers can inquire productively into the lives of their students, it is important for them to query their own experiences. Prospective teachers base many of their beliefs about teaching and learning on their own idiosyncratic educational experiences. Confronting, and reflecting upon, these implicit theories is part of the developmental process for novice teachers as they progress from thinking about themselves and their teaching to focusing more on student learning. The use of autobiography is helpful in determining the implicit theories of education and preconceptions that they bring to the table. Having student teachers write educational autobiographies brings their assumptions about students, teaching, and learning to the surface, where they are available for critical examination. And while writing their own autobiographies requires student teachers to reflect on their assumptions, reading the biographies of others enables them to gain new perspectives on teaching, learning, and contexts for development.[141]

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At Trinity University in San Antonio, TX, for example, candidates in the Master of Arts in Teaching program complete a racial autobiography assignment. Drawing on the framework outlined in Singleton and Linton's *Courageous Conversations About Race*,[142] this assignment is aimed at helping candidates expand their understanding of the development of their own racial identities and, through coming to know themselves and others, increase their ability to know their students. Candidates write about their feelings toward, understanding of, and engagement with race as these have progressed in their program and in their lives, and they share this autobiography with their cohort. The assignment is assessed on the analysis of their experiences and how candidates have come to understand them through the work.

Inquiring through child case studies. Effective preparation programs use systematic observation and case studies of children as a powerful pedagogy to help shape student teachers' developmental learning.[143] Drawing on data from observation, interviews, records, and analyses of student work, teachers directly apply what they are learning about child development to the case of a specific child. The case construction process enables learners to apply their theoretical knowledge to concrete examples, and the completed case provides a basis for evaluating their ability to do so.

Meaningful child observation assignments for prospective teachers typically use guiding questions and gear assignments toward specific concepts. Sometimes these observations are linked to specific learning tasks that can help prospective teachers begin to think about how to identify the zone of proximal development for students in different domains. At other times the observation is of children during free time, when they are able to choose activities, providing insight into how the child approaches learning and clues about the child's social, emotional, and physical abilities in different contexts. Engagement with families and community settings also provides insight for candidates, showing prospective teachers in more detail what the lives of their students are like inside and outside of school.[144]

As one example of this process, candidates at Bank Street College—one of the early developers of the observational approach—conduct child cases in many courses. One of the first of these, the Observation and Recording course, is designed to help prospective teachers learn to look closely and nonjudgmentally at evidence about children to inform all aspects of their teaching. In "O and R," as it is popularly called, candidates read texts on the observation and study of children while applying what they learn over several months of assignments. These include weekly written observations of a child at school, a paper examining the child in the context of his or her peers, an age-level study designed to see the child in the light of developmental theory, and observations of the child as a learner and member of a learning community. Class discussions center on children as learners and sharpen candidates' evidence-seeking skills as well as their awareness of their own cultural or other biases.

A similar assignment used to anchor the Adolescent Development course at Stanford University asks teacher candidates to shadow a student through a full day of school, meet with family members at home or in the community, and collect evidence of student work and learning—as well as interviewing and observing the student in school—so as to develop a more complete understanding of the student's experiences and to plan productive avenues of instruction. Weekly observation logs that form the basis for the final case emphasize nonjudgmental observation, so that student behaviors are not labeled, but rather examined to gain insight into the student and to form questions for the teacher to pursue. The class highlights a different component of adolescent development each week—including cognitive, emotional, social, and physical development—and residents use their observation logs to synthesize the information they gather in light of these topics.[145] Similar case studies of learning are conducted in courses on literacy, English learner development, and special education. Ultimately, child observation assignments help teachers develop the close observational skills and the ability to interpret developmental data they will need to construct tasks that meet children where they are and move them along the developmental pathways.

Inquiring through action research. Productive teacher education develops teachers who can learn *from* teaching as much as it prepares candidates *for* teaching. Action research is an important tool that is increasingly used in various countries to develop in teachers the skills for continuous improvement of teaching focused on students and their learning. A practitioner action research project is a form of "intentional, systematic, and rigorous inquiry."[146] When teachers use this methodology, they can focus on the needs of particular students; on broader questions about classroom practice (for example, whether a new approach to teaching mathematics is more productive and engaging); or on questions about school practices, such as the effects of the schoolwide discipline policy. A major goal is for educators to develop an inquiry stance toward their work and to develop skills for both asking productive questions and analyzing evidence that can contribute to answers.

An action research project is also part of the curriculum of the Newark Montclair Urban Teacher Residency at Montclair State University in New Jersey, where residents form an inquiry question and engage in multiple cycles of planning, acting, observing, and reflecting on the results. In a series of workshops, residents collaborate to consider their students' needs and to discuss how to improve instruction in light of their research findings, with the goal of understanding how they can conduct inquiries that will continually improve their teaching practice.[147]

Practitioner inquiry can also support cultural learning, whether through child case studies or analyses of school and community practices:

> By studying schools, prospective teachers can learn about the nature of the school as an institutional culture, exploring ways in which the context outside the classroom influences the lives of students and teachers. They can see the ways in which school policies and practices both support and hinder teachers' efforts to be culturally responsive.... If they study schools where equity and social justice are priorities, they might learn about ways that teachers can work collectively to bring about changes in their schools that will increase access to knowledge for all students.[148]

Collaborating in professional learning communities

The context of learning in teacher education is important. In particular, learning within professional communities provides mutual support, opportunities to learn from others' perspectives and expertise, and modeling for leading a collaborative classroom. Preservice programs organized in cohorts and in-service learning organized around teaching teams and networks create professional communities in which teachers can observe one another, share practices, develop plans together, and solve problems collectively. Interacting with students, other prospective teachers, expert teachers, and the tools of teaching (lesson plans, assessments, etc.) allows novice teachers to access "experiences, practices, theories, and knowledge of the profession" that would otherwise be unattainable.[149]

Within programs and schools, professional learning communities may also be organized according to subject areas, grade levels, or areas of practice. Learning communities may be formed across schools and universities—as the National Writing Project and Readers and Writers Workshop do—and such communities can be an integral part of clinical partnerships between educator preparation programs and professional development schools. An example of this comes from the University of Colorado, Denver, where the model of school–university partnership is based on the concept of "simultaneous renewal." Ongoing professional learning and improvement of practice are part of the work of candidates, clinical teachers, university faculty, and school staff. University faculty are hired for their expertise in practice as well as research, while coursework is connected to applications in clinical experiences. With k–12 student learning as the top priority, school and university educators collaborate to prepare new teachers and enhance the learning of veteran teachers, while engaging in collaborative inquiry.

Professional learning communities act as a source of support for candidates, providing them with places to get and share teaching and curriculum ideas and to solve problems of practice, while learning to create such communities in their own classrooms. Such communities also allow candidates to learn how to manage challenges that arise in collaborative work and to practice giving and receiving feedback. Working with other educators is part of professional practice and helps candidates experience how many perspectives can come together to produce a well-formed outcome, both in the classroom and in the school more broadly. This preparation for teamwork and collaboration helps prepare new teachers to modify and improve the schools they will eventually enter, hopefully enabling them to positively shape both their own classroom environments and the school as a whole. Cohorts not only serve as an organizational structure to support the learning of teacher candidates, but also model the importance of building authentic relationships

within learning communities. When combined with school partnerships, cohort-based learning communities expand to include k–12 schools and educators, creating deeper connections between preparation programs and district schools.[150]

Similarly, strong leader preparation programs engage prospective principals in collaborative communities of practice within their cohorts, and they model distributed leadership.[151] Thus, when candidates then go on to lead schools, they have models for and tactics to support their staff in collaborative learning.

Creating Systems That Support Educator Learning

Just as children's development and learning are shaped by interactions among the environmental factors, relationships, and learning opportunities they experience, educators' ability to use the principles of the science of learning and development in practice requires their immersion in a similarly supportive context. Building a positive, collaborative culture focused on whole child development and learning requires policies and practices that create pedagogical alignment between how systems support adults and how they support children.

Professional Development Supporting Educators' Practice

Many of the features of effective preservice educator preparation are equally found in effective in-service professional learning experiences. A recent review of research regarding professional development that proved effective in changing teachers' practices and improving student outcomes found that effective models share seven features. These approaches:

1. Are content focused, focusing on curriculum development and instructional practices that are central to teachers' work in the classroom.
2. Incorporate active learning, directly engaging teachers in analyzing practice, as well as designing and trying out teaching strategies.
3. Support collaboration, typically in job-embedded contexts, creating space for teachers to share ideas, learn together, and create communities of practice.
4. Use models of effective practice, providing teachers with a clear vision of what practices look like, including lesson plans, unit plans, assignments, samples of student work, observations of peer teachers, and video or written cases of teaching.
5. Provide coaching and expert support involving the one-on-one sharing of expertise about content and evidence-based practices, focused directly on teachers' individual needs.
6. Offer opportunities for feedback and reflection, including time and structures for teachers to intentionally think about, receive input on, and make changes to their practice.
7. Are sustained over time, providing teachers with adequate time to learn, practice, implement, and reflect upon new strategies that facilitate changes in their practice.[152]

Other research supports the effectiveness of these features. Studies find that the extent and duration of training make a difference in teachers' effectiveness in implementing programs,[153] as do on-site observations of teachers, with coaching and feedback on their teaching methods.[154] Effective professional learning for school leaders is also a continuous and shared endeavor, rather than an isolated event that can be easily discarded.[155] Like professional learning for teachers, it features collaboration, active learning, modeling, coaching, feedback, and reflection.[156] For educators across role groups, the process of learning to enact new skills is supported by skilled coaching in peer support groups that allow educators to discuss strategies and dilemmas as they develop, strengthen, and refine their abilities together.

These features can be seen in some effective programs that prepare teachers to support students' social-emotional and academic learning. An example is the Facing History and Ourselves program, which enables teachers to integrate social and emotional learning with academic learning for 6th- to 12th-grade students. The program's instructional methods emphasize reflection, interaction, cooperation, deliberation, and discussion of complex and meaningful social and civic issues. These are designed to produce in-depth understanding of historical processes and events applied to more humane engagement in today's world. Educators initially undertake up to 5 days of intensive training, with additional follow-up coaching on-site as well as virtual support during the school year. The program has an educator network that provides access to webinar-based professional learning communities and coaching options and a library of books, videos, and curriculum units. A randomized controlled trial study of 9th- and 10th-grade students from diverse backgrounds reported improved academic performance, improved social-emotional skills and attitudes, and improved teaching practices from this work.[157]

Another example, the PATHS program, which aims to promote peaceful conflict resolution, emotion regulation, empathy, and responsible decision-making, enables teachers to observe demonstration lessons, practice key lessons, and use curriculum materials that outline lessons they can adopt or adapt, along with implementation guidelines, suggestions for engaging parents, and a list of common questions and answers. In workshops, teachers plan for how they will use the PATHS concepts and lessons in their classrooms and how they will integrate the material with other academic content. Training continues over time once teachers are regularly implementing the curriculum, usually within 6 to 8 weeks, giving them opportunities to share what is going well, along with challenges they have encountered. These challenges are addressed using the same problem-solving approach that is taught to students, demonstrating pedagogical alignment. Studies find that with this training, implementation of the program results in improved behavioral and academic outcomes for students.[158]

In the PATHS program, staff also focus on how to integrate their practices schoolwide. Professional development is offered for principals, specialist teachers (including those with special-need classrooms), central office leaders, and professional staff (psychologists, social workers, etc.), as well as parents and community stakeholders. Administrators are provided training on how best to support the implementation of the program, including on how principals can become instructional leaders for social and emotional learning in their schools within a multi-tiered system of support. Administrators and school leaders also learn how to use these concepts in their daily routine with students, teachers, parents, and the community.

Systemic Support for Learning

As the examples above suggest, sustained changes require not just individual practitioner learning but a broader, systems-level approach at the school, district, and network levels.

Schoolwide support for learning grounded in the science of development

One well-tested schoolwide approach to systems change that draws on the science of learning and development is the School Development Program (SDP), which has helped transform school cultures and student achievement in hundreds of schools.[159] SDP focuses on teaching all members of

the school community to use the principles of child and adolescent development to create a positive environment for children's development along all of the developmental pathways—physical, social/interactive, psycho-emotional, ethical, linguistic, and cognitive/intellectual.[160]

The SDP model is rooted in the idea that *all* members of the school community must work together—from paraprofessionals and cafeteria staff to teachers, principals, and parents. The holistic involvement of all adults who collectively create the school community allows everyone to learn a common framework and knowledge base that all of them bring to the task of raising children together. This creates a coherent, safe experience for children, supporting greater progress in their ability to experience the secure relationships that allow them to flourish.

The goals of the SDP model are achieved through supporting staff development, as well as parent engagement and development, and developing a comprehensive school plan that includes social and academic components along with ongoing assessment and modification of progress.[161] School staff learn to craft positive behavior interventions for students as they come to understand that problem behaviors are a result of unmet needs and often can be traced to traumatic out-of-school experiences, rather than being a product of willful misbehavior. This insight alters staff perceptions of students, which in turn alters how staff manage issues that arise, leading to reduced behavioral problems and improved relationships. This approach can be incorporated within a multi-tiered systems of support framework, a strategy that targets interventions to address and help students overcome barriers to learning.

Illustrating pedagogical alignment, the SDP uses three guiding principles for how school staff work to build a positive school environment: consensus, collaboration, and no-fault problem-solving.[162] The guiding principles hold all adults involved accountable for modeling collaboration, no-fault problem-solving, and reaching consensus in each activity, thus creating relationships and common ground that allow adults to work more productively and continue to learn together within and across SDP schools that continue to convene for professional learning.[163]

The creation of strong relationships and shared decision-making among adults is an important component of creating a positive school climate and reducing stress among adults as well as students.

It is worth noting that the creation of strong relationships and shared decision-making among adults is an important component of creating a positive school climate and reducing stress among adults as well as students. This is a key consideration for educators, who consistently rank highest among professionals in their level of job stress. A 2017 survey of approximately 5,000 educators found that teachers were far more stressed than other professionals, reporting their work was stressful 61% of the time, a rate that has increased in recent years.[164]

There are four main sources of teacher stress: school organization that lacks strong leadership and a healthy climate, escalating job demands, limited autonomy and decision-making power, and lack of resources to bolster teacher social and emotional competence.[165] Initiatives that teach leaders and staff how to problem-solve and make decisions together also improve school climate and build educators' social-emotional skills while reducing many sources of stress.

Network support for professional learning

Some schoolwide approaches, like the SDP, have evolved into networks of schools that have been developed around practices grounded in the science of learning and development.[166] These networks hold promise as a catalyst for developing educator capacity to learn from practice and build a professional knowledge base that enables the field to address complex educational problems.

Another example is the EL Education network (formerly called Expeditionary Learning), which creates a schoolwide approach to whole child education, incorporating social and emotional learning into academic learning for 6th- to 12th-grade students—an approach that has been found to produce stronger achievement for students than their similar peers in comparison group schools.[167] The program offers an open-source English language arts curriculum that focuses on building cultural sensitivity and appreciation for diversity. The whole-school transformation needed to become an EL Education school requires a multiyear commitment from leaders and staff, wherein staff take significant ownership of the goals and processes of the change. Typically, educators from the entire school experience shared training over 2 to 3 weeks during summer break, plus a total of 30 to 40 days on-site and off-site.

The first step in this process is for staff to identify a set of character traits and behaviors for themselves and students—again illustrating the pedagogical alignment that allows staff and students to learn and grow in similar ways together. The program emphasizes both relational character (e.g., kindness, honesty, and integrity) and performance character (e.g., organization, perseverance, and craftsmanship) in students and staff. Teachers plan opportunities to develop character through collaborative work that takes place in learning "expeditions" and community-building activities. Students participate in service learning to make meaningful contributions to the community while supporting the development of interpersonal and academic skills. The learning process for educators continues in active networks of schools that have adopted the EL approach. Teachers and leaders have access to curriculum resources, videos of teaching practice, samples of student work, regular conferences, workshops, training for coaches, and site seminars in which schools invite others to visit and learn particular strategies they have found successful.[168]

Another school improvement network that has enabled schools to use practices that are built on the science of learning and development is the Institute for Student Achievement (ISA), a nonprofit high school redesign organization that has worked successfully with many schools in New York.[169] Two quasi-experimental studies of ISA schools found that ISA significantly improves high school attendance, credit accumulation, grade promotion, high school graduation rates, and college attendance and persistence rates.[170] ISA's model is approved by the U.S. Department of Education as an evidence-based whole-school reform model for high schools. ISA's research-based framework uses seven principles to design schools, all of which are well-rooted in the science of learning and development:[171]

1. **An inquiry-based approach to a college preparatory curriculum** that is implemented through an organizational and instructional infrastructure for student support, social-emotional development, integration of literacy and numeracy across the curriculum, multiple forms of assessment—including formative and summative performance assessments that engage students in processes of feedback and revision—and internships and community service.

2. **Dedicated interdisciplinary grade-level teams of teachers** who teach the same cohort of students to personalize the school environment and provide a support network for student achievement.

3. **Continuous professional development** that includes individual and team coaching and ISA-sponsored institutes for cross-school professional learning.

4. **Distributed counseling** that involves all faculty in the academic, social, and emotional development of students through structures such as advisory programs that provide each student and his/her family with a school adult advocate.

5. **Extended school day and school year** arrangements that provide extra time for students to have the opportunity they need to get assistance with homework, test preparation, internships, and community service projects.

6. **Parent involvement** in school activities promoted through the open exchange of information between parents, teachers, and counselors, and regular feedback to parents regarding their children's school experience and progress.

7. **Continuous organizational improvement**, including structures, processes, and data use that engage the school in continuous learning and ongoing changes to strengthen student outcomes.

These features are similar to those identified in a study of three deeper learning networks that collectively span over 400 schools throughout the United States and internationally.[172] The study sought to discover how these sophisticated instructional practices—which have tended to exist in small educational niches—were able to spread across many schools without becoming diluted or distorted, successfully reaching students who are otherwise typically marginalized. The networks in this study achieved successful results by:

- using a well-defined vision for deeper learning and equity to guide all aspects of school design and implementation, including transformations in how adults and students are organized to work together within schools;

- collaborating with local stakeholders to ensure that the model is responsive to and embraced by local communities;

- building and maintaining systems of professional learning that support teachers and school leaders to enact deeper learning strategies together, including opportunities to see and examine new pedagogies in action, curriculum and assessment resources to support the use of these pedagogies, the creation of professional learning communities to plan and reflect together within and across schools, and coaching for both leaders and classroom educators;

- developing a leadership pipeline so that new schools are led by educators who have both relevant hands-on training in leadership for this kind of practice and previous deep experience enacting these pedagogies and strategies; and

- maintaining a learning orientation with opportunities for needs assessments and ongoing access to multiple successful models so schools continually improve.

Districtwide Support for Professional Learning

There are two key considerations for districtwide support of professional learning:

1. Supporting new practices is a broad systemic undertaking, not limited to individual teachers in their classrooms.

2. Designing professional learning is an iterative process of refinement and improvement rather than a set of canned workshops.

Lessons about how to support this iterative learning have been developed and tested through design-based implementation research (DBIR), which aims to scale successful professional practices so that they are applicable in diverse contexts.[173] DBIR aims to simultaneously design interventions and improve their implementation. Rather than focusing primarily on the fidelity of implementation, the approach engages learning scientists, policy researchers, and practitioners in inquiry that seeks to understand the variation in learning conditions—for example, access to high-quality materials and teaching that students of color from low-income families often lack—and to intervene to improve those conditions through professional development and improvements in organizational processes.[174]

One example of this is the Middle School Mathematics and the Institutional Setting of Teaching project, which worked over 5 years to identify the key elements needed to support mathematics teachers' development of ambitious and equitable instructional practices, rooted in research on mathematics learning, on a large scale.[175] These practices enable teachers to understand their students' zone of proximal development and scaffold instruction so that students can engage in cognitively demanding tasks—those that require deep understanding of content and procedures rather than mere memorization. Teachers also help students learn to engage in productive instructional conversations so they can deepen their understanding of mathematics by discussing and reflecting on their own and their peers' understanding of concepts. Ultimately, this builds a supportive classroom space that employs productive instructional strategies, social and emotional learning, and individualized supports.

Researchers worked with educators in four urban districts to reorganize professional development practices at the systems level by creating a coherent instructional system supported by instructional coaching, teacher networks, school instructional leadership, and district instructional leadership. As they refined this work they identified the importance of ongoing intentional learning events (i.e., consistent meetings on a specific subject, in which teaching teams have active opportunities to learn about problems that are close to their classrooms); coaches who offer support to principals and teachers in identifying, implementing, and reflecting on best instructional practices; organizational routines and protocols for observing and reflecting on practice; and tools such as instructional tasks, students' written work, and class video recordings that generate dialogue, reflection, and improvement on existing practices. These insights reinforce the following observation:

> Teachers do need to work together to improve instruction and student learning, but administrators also need to be part of the process. The process may be as simple as having principals participate in professional development activities for teachers, or as complex as reorganizing the formal authority structure of the school. In any case, it requires a rethinking of the "bright line" that often separates administration and teaching.[176]

Rethinking this "bright line" reinforces the whole-school investment in instructional change. In addition, developing school leaders' conceptual understanding of instructional practices supports school leaders in identifying teaching and learning that is conceptually deep as well as pedagogically sound.[177] Also key is that professional learning be supported by leaders who help design school systems that consistently reinforce collaboration, empathy, a growth mindset, self-efficacy, and a sense of community. School systems that effectively implement the science of learning and development align themselves around a vision that prioritizes these skills. Beginning with a foundational needs assessment to understand areas of strength and growth, they design sustained professional learning opportunities for faculty and staff, and they continuously reassess their capacity to improve upon their practices.

Summary and Conclusion

Emerging knowledge from the science of learning and development holds great promise for the realization of children's potential as educators gain a deeper understanding of how to use these insights to support their students through safe communities and secure relationships; integrated social, emotional, and academic supports; and the kinds of teaching that enable children ultimately to guide their own learning. Concentrated efforts will be needed to create professional learning opportunities that can help educators develop the kinds of knowledge, skills, and dispositions needed to enact these insights. These efforts will be most successful if they offer pedagogical alignment that allows educators to experience the same kinds of learning they will use with students and if they engage educators in sustained, collegial efforts to practice new skills and strategies.

Furthermore, since these insights imply a set of practices very different from the presumptions on which many schools are based, a broader conception of learning is needed—one in which organizational and system learning figures prominently and in which learning for school and system redesign is essential. This learning should aim to build a collective understanding of how schools can be designed for strong relationships; provide environments full of safety and belonging; offer rich learning experiences; explicitly develop social, emotional, and cognitive skills and mindsets; and ensure that student supports are readily available to remove barriers to learning. In these settings, teachers and school leaders prepared to enact the science of learning and development will be able to make a significant difference in the lives of the students they serve.

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