

How the Science of Learning and Development Can Transform Education

INITIAL FINDINGS



OCTOBER 2019



Science of
**Learning &
Development**
Alliance



Who We Are

The Science of Learning and Development (SoLD) Alliance is a growing partnership of leaders and organizations who believe that the science of learning and development presents powerful lessons to transform our education and other child-serving systems to help each young person achieve their full potential. It is led by:

- **Pamela Cantor, M.D.**, Founder and Senior Science Advisor of Turnaround for Children
- **Linda Darling-Hammond, Ed.D.**, President and CEO of Learning Policy Institute
- **Bethany Little and Scott Palmer, J.D.**, Managing Partners at EducationCounsel
- **David Osher, Ph.D.**, Vice President at American Institutes for Research
- **Karen Pittman**, Co-Founder, President & CEO of the Forum for Youth Investment
- **Todd Rose, Ph.D.**, Co-founder and President of Populace and Director of the Mind, Brain, and Education Program at Harvard Graduate School of Education

The SoLD Alliance is committed to elevating the science of learning and development to foster stronger, more equitable education systems so that all children can thrive. Learn more at www.soldalliance.org.

The SoLD Alliance governing partners would like to acknowledge the many individuals and organizations that contributed to this brief, in particular Richard Lerner, Ph.D., and members of the SoLD National Advisory Committee for sharing their deep expertise on the topics contained in this paper, as well as Ned Potter, Amber MacDonald, Ward Circle Strategies, and ProjectED for their tireless effort and communications guidance. This brief is made possible in part by a grant from the Chan Zuckerberg Initiative DAF, an advised fund of Silicon Valley Community Foundation.

© 2019 Science of Learning and Development Alliance

Introduction

All children can learn and thrive. Many people who work with children believe this to be true. But the science of learning and development shows that this idea is more than just a belief. It's a scientific truth—and, more importantly, it's a foundation upon which we can design and build learning environments and educational systems so that every young person can achieve their full potential.¹

In recent years, the science of how young people learn, develop, grow, and come to master complex skills has advanced substantially. This knowledge is critical for the education of all children, but it is especially powerful in creating educational equity where we have fallen short in the past. We may profess to believe that all children are capable of learning, but our educational practices and policies too often reflect the opposite, including marginalizing those who don't respond to “traditional” K-12 educational approaches.

When we understand the complexities of human development, however, we can see that every young person—no matter their background, income, race, gender, learning difference, emotional or cognitive starting points, family history, or genetic and epigenetic makeup—is capable of realizing their talents, skills, and intelligence, and that the science of learning and development can help show us why and how. This hopeful story must inspire us to work harder and smarter to meet each young person's potential so that they can thrive in school and beyond. We owe our children no less.

Education Systems Defined

The SoLD Alliance understands that our “education systems” are not limited to the traditional Kindergarten through 12th grades. Instead, they encompass early childhood settings, continue after high school, and expand beyond the classroom. Before- and after-school programs, youth development programs, and other community-based learning environments are all critical factors in helping young people develop socially, emotionally, academically, and physically. We also use the term “educators” to include all of the adults who are engaged in supporting learning and development across these settings. Additionally, the SoLD Alliance recognizes the essential role that families, peers, and communities play in the educational life of children.

¹ Respecting changing gender norms, this document uses “they” or “their” as a singular pronoun rather than “he” or “she” when gender is unspecified.

Overview

This brief summarizes several initial lessons from contemporary research that have significant implications for those working to advance opportunity, equity, learning, and youth development.

First, some major themes:

- **Every child, no matter their background, has the potential to succeed in school and life.** Despite current education practices—particularly in K-12 schools—that were often founded on the idea that some individuals had limited potential (most often singled out by race or class), these studies confirm that everyone can have a path to positive development and successful learning. Education systems can support success by being attuned to children’s diverse needs, interests, and abilities.
- **No two young people learn in precisely the same ways.** Brain development and learning do not proceed in a straight line, and neural connections uniquely zig and zag as they are created. Strong relationships with adults and peers, individualized supports, and well-designed environments all help ensure that each young person’s own zig-zag learning and development move forward toward success.
- **Children’s ability to learn is strongly intertwined with their social, emotional, cognitive, and physical needs.** This concept is obvious to any teacher who has tried to teach hungry, anxious, or distressed children. To be successful, education systems must consider and address the full range of children’s social, emotional, cognitive, and physical needs. This kind of integrated approach is central to building the neural connections that power long-term learning and the development of complex skills.
- **The environments, experiences, and cultures of a young person’s life are more influential than their genes.** In the past—and even today in many

places—a child’s genes have been treated as their destiny. But genetics turns out to be less important to a child’s development than *epigenetics*—the science that studies which genes are activated by environments and how experiences within these environments influence the ways genes are expressed and shape physical and behavioral characteristics.

How Do We Know?

Working with a large group of leading scientists from many disciplines, the SoLD Alliance synthesized research from diverse fields into three initial peer-reviewed papers covering the science of learning and development and implications for educational practice.

The first two papers, published simultaneously in the journal *Applied Developmental Science*, are:

- *Drivers of human development: How relationships and context shape learning and development*
- *Malleability, plasticity, and individuality: How children learn and develop in context*

The third paper is:

- *Implications for educational practice of the science of learning and development*

We are also developing other papers on policy actions to advance education and related systems, on additional implications for educational practice in and out of the school setting, and other topics.

- **The human brain is remarkably malleable and can be changed by strong, supportive relationships and conditions they create.** Across a young person's life span, educators, mentors, coaches, counselors, peers, and family members, and the experiences for children that they design and provide, can have enormous influence—including at the cellular level—on every young person.

The implications of this research are transformative: If we make good use of what the science of learning and development is telling us, we can re-design our educational systems to better serve each learner. We can and must educate and support every young person to develop foundational skills and knowledge, help them develop intellectually and emotionally, and set them on their own paths to grow and flourish.

History

Public education in the twentieth-century United States was predicated on the belief that there was such a thing as an “average” person, that children should be placed along a bell curve, and that the best approach to education was to offer a standardized pedagogy and curriculum to children within age-based cohorts. It generally focused on teaching students to memorize content rather than to develop and master knowledge and skills or to discover their unique interests and talents. This system was inherently exclusive. If 30 percent of students did well enough to move on to college, that was considered a good result. It disproportionately benefited students from privileged backgrounds and was used to “weed out” those who did not fit the mold. This system was especially detrimental to young people of color and other underserved children, and often used the science of the time to justify a racist, classist, and oppressive system.

The public education system of the twentieth century wasn't designed to unleash the potential of every young person. Instead, it was designed, in most cases, to ration educational resources inequitably, disregard the importance of diversity, and elevate a few over the many. The result is that generations of children were locked out of early childhood education, equitable K-12 education, higher education, and adult success, all because they fell outside a restrictive average or were not born white and male. Our communities, workforce, and national leadership are poorer from losing this untapped potential as well.

Today, cutting-edge research has shown that there is no such thing as an average child—and that, with the right conditions, every young person can thrive.

Many educators are already reorienting their approach to reflect this truth. Some understand it reflexively, whereas others are guided by evidence-based methods that are beneficial for a wide range of students. But the scientific information that supports these efforts has not been widely shared or valued by the structure or culture of our education and other youth-serving systems. To better serve students, educators often have to reorient their approaches outside of or despite the system. And too many capable and dedicated educators are basing their approaches on outdated paradigms.

Accordingly, the core mission for the Science of Learning and Development (SoLD) Alliance is to empower leaders at all levels and in all education settings with greater knowledge of the science of learning and development to help transform education in the United States. We hope that this report will provide a basis to create environments, practices, and policies that empower children to achieve their full potential, particularly those least served by current systems. If we can build systems that are deeply informed by the science and designed for equity, then the talents and skills of all children will be cultivated and revealed—to their benefit and to ours.

INITIAL FINDINGS FROM

The Science of Learning and Development That Can Transform Education

To elevate the key insights from this research, we have articulated several initial core findings that have significant implications for our education systems. It should be emphasized that these findings are overlapping and need to be understood together in an integrated way. This list of key findings is, and always should be, a work in progress. As the science of learning and development advances, and our work expands, we will learn and say more about these and other findings, and their implications.



POTENTIAL

Each young person has significant potential to learn and thrive.



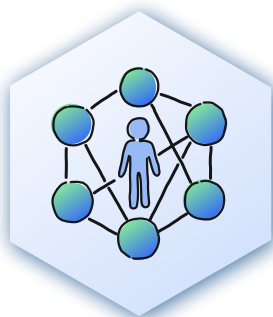
MALLEABILITY

Brains are remarkably malleable and resilient throughout life.



INDIVIDUALITY

Every young person learns and develops differently. .



CONTEXT

Experiences, environments, and cultures are the defining influences on development.



RELATIONSHIPS

Strong, trusting relationships are essential to learning and development.



INTEGRATION

Cognitive, academic, social, and emotional development are inextricably linked.



CONTINUUM

Human development is a progression, but not a linear one.

Potential

Every child has great potential.



Every young person has great **potential** to learn and thrive. **All children develop billions of neural pathways that can enable learning and positive development.** These include multiple pathways to

learning foundational knowledge and skills, at every stage of life, and to discovering multiple areas of talent and interest that create potential for fulfillment in school and in life. Realizing this potential—finding and forming the integrated neural connections around complex knowledge and skills—depends chiefly on how we understand and support each young person's unique pathways and how we shape their experiences, environments, culture, relationships and learning as a whole child.

The concept of genetic determinism—that an individual has a fixed capacity to learn and adapt, determined at the beginning of life—has been shown to be a myth. Genes are chemical followers, and within each person only a small portion of their genetic make-up is activated over the course of their lives. Indeed, the validated, mainstream scientific literature of recent decades is in strong agreement that every young person has the potential to thrive—if adults responsible for their learning and development challenge their own assumptions about who can learn and how to bring out abilities and talents in every child.

There is no “bell curve” on human potential.

Malleability

The brain is highly malleable, from birth through adolescence and beyond.



The tissue that makes up a young person's brain is more easily changed than any other organ in the human body. It is constantly being shaped by experiences, environments, and relationships

—both positively and negatively. Neurological development and remodeling occur more regularly in human beings and extend for longer periods than in any other mammal. These processes begin in utero and continue well into early adulthood—certainly past one's mid-twenties—and beyond. Learning also continues across the lifespan as individuals learn from experiences and how they make sense of those experiences.

This **malleability** is more important than scientists of earlier decades recognized. Researchers previously thought that most development only took place in the first few years of life. The truth is much more

encouraging: **Lifelong learning can happen for virtually anyone under the right circumstances and with the right supports.**

We focus on two particular periods of heightened sensitivity and change in a person's life. The first is from birth until approximately age five, and the second is in adolescence. During these times, a young person makes important progress, such as developing an identity and learning more and more complex skills. But neurological development hardly goes quiet in between or after. Even in late adolescence, new experiences stimulate the creation of synapses in the brain—the connections that send signals between neurons—to form at a rate of hundreds per second.

Ability to learn does not end, and adversity in life is not decisive.

Individuality

Every child learns and develops differently.



All of us have unique neurological structures, genetic expression, backgrounds, and personal experiences. **Because of this individuality, we each have a unique, dynamic learning path.**

Just as no two children have the same interests, vulnerabilities, and personal strengths at any one moment, no two children will come to understand educational concepts in exactly the same way or at the same time.

There is no such thing as an “average” learner. Children do not learn as uniform cohorts. Each young person will learn different material in different ways and at a different pace to build deep understanding—and forge new neural pathways—that become a foundation for new knowledge and skills. Some children may acquire a specific skill only to lose it and learn it again later on. These individual pathways may form patterns across children that can inform teaching and learning, but those will never be singular or tied to a simple “average.”

Variability in and among children is the norm, not the exception. So how can we expect schools or other settings designed for an “average” learner to work equally well for all students?

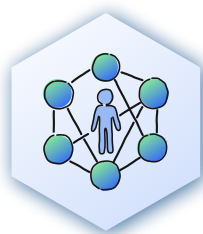
The learning process is too complex, and variability among children is too great, for reliance on averages. Instead, several research teams have used the metaphor of a “constructive web”—multitudes of complex relations between an individual and their context—to help visualize how an individual young person may progress developmentally.

Because of this new understanding of how each of our brains uniquely processes information, modern research has begun to put a premium on studying the individual, so that educators can see what works best for each learner and under what conditions.

There is no “normal” or “average” learner.

Context

Experiences, environments, and cultures are the defining influences on development.



Just as our brains process information in unique ways, the experiences that shape us are at least equally unique across the breadth of our lives. And our brains respond to the world around us—to **context**—uniquely as well.

We don’t receive or process information in a vacuum. Our learning and development are deeply affected by our physical and emotional states, and these states

are moderated by our cultures and context, which includes the effects of those with whom we have immediate contact as well as external factors such as policies, norms, and structures that affect them and us. Think about how well we as adults function in our daily lives when we are afraid, confused or threatened—or conversely, how we function when we are confident and relaxed. Children are no different and will struggle, or thrive, under the conditions they experience as well.

CONTINUED

We use the word context to describe how children’s development is affected by experiences, environments, and cultures. Culture is particularly important because it affects and is affected by what happens in context. Indeed, a young person’s culture both shapes the nature of learning environments and shapes the ways in which they experience and respond to these environments. Within school, for example, culture influences the literature children will have access to and read, and it affects how children internalize, respond to, and learn from that literature. Culture also shapes how adults view children and, correspondingly, the deeply consequential choices they make as they go about teaching and supporting children.

Nothing happens to the developing brain that is not contextualized. Two children may take the same mathematics course, for example, but one may find the work easy, whereas the other struggles to understand the material. Why? Did one child attend a school where their safety and belonging were nurtured while the other was labeled as a troublemaker? Did one child benefit from a calm, supportive environment at school as the other was in a chaotic classroom? Do these children have equitable exposure to mathematical concepts, to manipulatives, to a responsive, caring teacher with a good handle on how to correct and explain common mathematical misconceptions?

In the past, educators may have been tempted to attribute the differences between these two children as a result of genes or other forces outside their control. The young person who easily learns, in particular environments, would be considered inherently more intelligent than the one who

struggles. But when we see the full picture—a young person who is provided what they need to thrive, whereas another lacks access to necessary supports, resources, and opportunities that meet their individual needs and pathways—it becomes easier to understand why there is a difference and how to help every young person travel their unique pathway to learning and success.

Recent scientific literature in the growing field of epigenetics shows that the view that potential and intelligence are merely inherited is both scientifically and biologically incorrect. **Our environment, experiences, and cultural context determine which genes play a large and active role in shaping our physical and psychological attributes.**

The way young people learn and develop depends particularly on where and how they discover who they are. They experience positive forces that nurture them, like playing without fear or exploring nature, and others that threaten their development, like the influences of poverty, bias, racism, or abuse. Importantly, a supportive context can help children overcome negative experiences and develop resilience and a belief in their ability to succeed. Educators who understand the need to design and support positive contexts and a holistic, whole-child approach will have more success reaching and teaching all children, and particularly those children least served by most current education systems.

Learning environments can be designed for positive development.

Food For Thought

“There is no separation of nature and nurture, biology and environment, or brain and behavior,” wrote Kurt W. Fischer and Thomas R. Bidell in 2006, “but only a collaborative coordination between.”

Relationships

Strong, trusting relationships are essential to learning and development.



The presence and quality of our **relationships** may have more impact on learning and development than any other factor. Indeed, relationships are the primary processes through which our biological

and contextual factors are reinforced. **Emotion and cognition are inextricably linked, and one of the best ways to promote a positive context is to create opportunities for positive developmental relationships, both in the home and outside of it.**

Positive relationships—supportive families, an involved teacher, a caring coach—serve as the foundation for children’s ability to adapt, establish good emotional health, foster social connections, and build the complex neural processes that make us resilient and effective learners.

One way to see the power of relationships is to examine the limbic system, which is the learning center of our brains. It is exquisitely sensitive to experience, and plays a role in how we control attention, focus, memory, and emotion. Two key hormones mediate the structures of this system:

- The first is cortisol, which responds to stress, and can make children irritable and unable to concentrate or focus—and, with prolonged exposure, can cause long-term negative health effects.

- The second is oxytocin, released when we enjoy feelings of trust and love. Oxytocin reduces our blood pressure and helps us manage stress, alleviating some of the negative effects of cortisol. In other words, love, trust, friendship, and mentoring can help reduce the damage that problems like poverty, discrimination, and anxiety cause in children’s lives.

Of course, it’s not news that children need strong, trusting relationships. However, we too often don’t value the importance of relationships in children’s lives enough to properly build their positive aspects into the design of our education systems.

Education systems can support this positive development by fostering opportunities for children to build strong, trustful relationships that help them grow, build identities, explore the world, and learn with positive reinforcement—and by providing adults with supports so that they have the ability to attune to children’s needs in a timely and supportive manner.

Relationships ignite development and help us learn.

Integration

Intentional integration accelerates learning.



Despite common misconceptions, learning is a full-body experience, not something that happens only through academic experiences or only in our minds. We learn through our emotions and feelings, through engagement with others, through bodily motions, by examining objects in our hand or ideas in our minds, and by moving through time and space. We learn by overcoming failure or frustration, and feeling happiness when we figure out problems. We learn through relationships, interacting with our peers and teachers, and observing and influencing our communities. **Learning is integrated with every aspect of our existence: academic, social, emotional, cognitive, physical, and identity-building.**

In other words, the brain is nested in the body—and both are nested in a young person's physical, cultural, cognitive, and emotional environment. The brain grows in its ability to do complex things, such as reading, riding a bicycle, or developing resilience, when structures of the brain become integrated and wired together.

The idea that we are connected to our bodies and our environments is called embodiment. Multiple neural, relational, experiential, and contextual processes converge in the brain—in ways unique to each young person—to produce complex skills and an identity that, under favorable conditions, will continue to develop positively.

Cognition and emotion have traditionally been regarded as separate. However, the research drawn on by the science of learning and development over the last two decades shows that thinking, feeling, behavior, and social relationships are all inextricably linked and work together to produce learning. We now know that stress can have powerful effects on the developmental process, interfering with a child's confidence, motivation, and curiosity. Similarly, a child's early learning experiences and sense of motivation can contribute in major ways to self-control, self-direction, and resilience.

This **integration** is why children must be seen as whole people and taught holistically. Children need support in developing self-regulation and executive functioning. They must develop physical and psychological wellness in order to understand their self and their relation to the world. These attributes are as important to positive development and personal growth as learning reading, math, or the arts, and are critical to learning those things as well.

Our brains develop higher order knowledge and skills as a result of integrating social, emotional, academic, and other experiences.

Continuum

Human development is a progression but not a linear one.



Just as children currently move up through grade school, we often think of learning as a linear process. First they learn A, then B, then C.

But, in reality, learning and development look less like a straight line on a chart; instead, imagine an impressionistic painting. Up close, it might seem messy, with chaotic brushstrokes going back and forth. As previously noted, children may learn skills, and then may lose them. They may attempt certain concepts and fail, only to grasp them later.

However, if we step back from the painting, we can see that each small, seemingly-confused brush stroke makes up a complete picture in the end. Children learn and grow from where they are—building on their individual experiences and understanding—even though they don't do so linearly or in the same way or pace. **Progress along a continuum is driven by the right degree of challenge—and productive failure—for each learner.**

These two images—of learning and development that are both variable and progressive, moving from simplicity to greater complexity—are compatible; they are seen in every young person. The brain grows, changes, and remodels as they develop,

shaped by biological processes as well as by contexts that encompass their environments, experiences, relationships, and cultures.

Some developments do have to take place in a particular order. For example, neural pathways that are created during adolescence produce new skills and abilities that cannot be expressed earlier in life. Certain critical skills, like self-regulation and executive function, will have unique dimensions in specific periods. The executive functions of a preschooler will be different than those same skills in a teenager.

That said, there is no pre-determined path from the relatively undifferentiated tissue in the infant brain to the far more connected structures and neural pathways of the mature brain. The brush strokes of an individual's path will be unique. It can understandably be difficult to think of a child's many advances and setbacks as part of the same painting. But it is essential for our education systems to see the development into maturity as one developmental arc—a common picture that will be completed with great variability from person to person

Each child's learning builds on what came before.

Conclusions

The science is clear and full of promise: All children can learn and thrive if we transform how we educate and develop them. But we won't fulfill this promise if we remain in thrall to an education system that was never designed to fully develop every young person and indifferent to other systems for learning that have embraced a developmental approach.

The SoLD Alliance does not pretend to have all the answers about how to design systems that support every child. **But twenty-first century science has given us better answers to problems that have vexed us—knowledge we can use to change the lives and reveal the potential of our young people.**

The research discussed in this paper shows that all children have talents, that all children can succeed in intentional, well-designed, developmental contexts, and that the methods we currently use to develop, measure, and categorize ability are inadequate for, and in many cases undermining of, our goals. If we hope to educate and empower all children, no matter their background, we must recognize that there may be as many pathways to success as there are individuals. We still have educational systems that marginalize and exclude far too many children, in particular the growing number of young people who live in underserved communities and who suffer serious stresses. Their needs are not being met and their talents are not being nurtured.

If education is to be equitable for all, then it is necessary to transform our nation's education systems—to ensure that they are deeply informed by the science of learning and development and designed for equity. This transformation will take considerable thought, effort, and courage. However, with science guiding our path, there is no reason we cannot rise to the challenge and create education systems that help all children reach the heights of their enormous potential.

To realize the power of transformation, we need education systems that are themselves designed to be malleable, to integrate the growing knowledge from the science of learning and development, to learn, and to improve over time.

There is tremendous promise in the work being done on many fronts by leaders and practitioners within the research community and in the education and youth-serving fields that demonstrates what is possible for all children. But there is much work remaining to be done. New findings always raise new possibilities, along with new questions.

For example, attending to trauma and stress without addressing the need for individual pathways will nurture the potential in some children but continue to relegate others to educational failure. **We should not expect children to adapt their learning to our flawed system; we must re-design our systems to understand and adapt to each learner, with the goal of helping them to discover and realize their potential.** Only then will we bring to bear the range of positive relationships, conditions, opportunities, practices, and supports necessary to nurture and empower each young person's pathways to success and thriving.

The late educational psychologist, Benjamin Bloom, provided many important ideas for twenty-first century education. In our research, we were moved by his quote: "What any person in the world can learn," he wrote, "almost all persons can learn if provided with appropriate prior and current conditions of learning." We understand that given our current reality, this may seem overly optimistic, but the science of learning and development tells us that Bloom is right.

In fact, if we build the right systems—with the best knowledge and stakeholder engagement, and continuously improved based on what we know about how children learn and develop—then each young person can not only succeed in school but also find their path in life. The opportunities they find will match their individual talents and interests, and they will thrive in and contribute to their communities, benefiting us all. **Building these systems is an urgent, immediate and long-term venture, and the science of learning and development can help show the way.**

Now that we know better, it's up to us to do better, for all our children.



Science of
**Learning &
Development**
Alliance