



Designing for Learning Primer

A Synthesis of Key Insights from the Science of Learning and Development

©Transcend, Inc. 2020 (v1.3)



About Transcend

Transcend is a national nonprofit organization focused on innovation in school design. We support communities in creating and spreading extraordinary, equitable learning environments.

To learn more about working with Transcend, reach out to us or visit our website.

🌐 www.transcendededucation.org

✉️ explore@transcendededucation.org

🐦 [@transcendbuilds](https://twitter.com/transcendbuilds)

Authors

Jennifer Charlot, Transcend Partner, Build Knowledge

Cynthia Leck, Transcend Partner, Build Knowledge

Bror Saxberg, Transcend Board Member and VP,
Learning Science at the Chan Zuckerberg Initiative

Acknowledgments

Thank you to the following people and organizations, who contributed heavily to this resource by providing thoughtful inspiration and feedback along the way.

Researchers Advisory Group

Pooja Agarwal, RetrievalPractice.org

Ulrich Boser, Center for American Progress

Sheldon Horowitz, National Center for Learning
Disabilities

Lisa Quay, Mindset Scholars Network

Benjamin Riley, Deans for Impact

Gabrielle Schlichtmann, Harvard Graduate School
of Education

Brooke Stafford-Brizard, Chan Zuckerberg Initiative

Ahna Suleiman, Center for the Developing Child,
University of California, Berkeley

Jessica Tsang, Chan Zuckerberg Initiative

Melina Uncapher, Neuroscape, University of California,
San Francisco

2017–2018 NewSchools + Transcend Collaborative Cohort

Bard High School Early College

The Brooklyn STEAM Center

Catholic Schools in the Archdiocese of New York

Chicago International Charter School

Collegiate Academies

Edgecombe County Public Schools

Ednovate

Education Leaders of Color

San Marcos Consolidated Independent School District

Strive Preparatory Schools

Yellow Hats League Advisory Group

James Bailey, Learning Schools of Texas

Justin Ballou, Campbell High School

Morgan Beidleman, Educational Interventionist and
Consultant

Ann Berger, Mott MacDonald

Alexandria Bragg, Woodward Academy

Ivan Cestero, Avenues: The World School

Christine Dahnke, Orange County Public Schools

John Faig, St. Patrick's Episcopal Day School

Elana Feinberg, Elana Feinberg Educational
Consulting, LLC

Nishita Gupte, Building Excellent Schools

Verenice Gutierrez, LEEP Dual Language Academies

Beth Holland, EdTech, Education Week, Consultant

Jin-Soo Huh, Distinctive Schools

Mark King, Lift Collective, Toad+Tadpole

Miho Kubagawa, NewSchools Venture Fund

Ross Lipstein, Summit Public Schools

Tricia Maas, Committee for Children

Ron MacDonald, Consultant

Nate McClennen, Teton Science Schools

William Murphy, IDEA Public Schools

Grace O'Shea, room2learn

Amanda Rychel, Distinctive Schools

Deb Sawch, Education Consultant

Randy Weiner, BrainQuake

Transcend Team

Every member of our team contributed to this resource at some point along the journey. Thank you. Your ideas, encouragement, and assistance made this a more impactful resource. And a special thanks to Kate Coxon who undertook the initial research and writing for this project.

Table of Contents



Introduction

Purpose and Organization of This Primer	5
How This Resource Complements Others	5
Our Framework for Learning	7
Common Themes Across the Framework	11

Cognition

Overview	15
Principle 1: Focused Attention	17
Principle 2: Manageable Cognitive Load	19
Principle 3: Meaningful Encoding	23
Principle 4: Effective Practice	27
Principle 5: High-Quality Feedback	29
Principle 6: Metacognitive Thinking	31

Motivation

Overview	33
Principle 7: Value	35
Principle 8: Self-Efficacy	37
Principle 9: Sense of Control	39
Principle 10: Constructive Emotions	41

Identity

Overview	43
Principle 11: Self-Understanding	45
Principle 12: Sense of Belonging	49
Principle 13: Navigating Identity Threats	51

Individual Variability

Overview	53
Principle 14: Life Experiences	55
Principle 15: Developmental State	59
Principle 16: Learning Differences	63

Conclusion

Explore More	66
Apply What You've Learned	69
What's Next for Transcend	71

Appendix

Principles and Implications Lists	73
Works Cited List	79



Help Us Continue to Improve This Resource

One of our core values at Transcend is Perpetual Beta—we are always looking to learn, grow, and improve. As a result, this resource, like all of our knowledge resources, will be updated regularly in response to feedback, lessons learned, and external research developments. If you have comments or suggestions for our next iteration, please contact cynthia@transcendeducation.org.

Introduction

Purpose and Organization of This Primer

Two of the most important questions in designing, or redesigning, learning environments are: **How does learning happen?** and **How can we best create environments that support learning?** While empirical research has unearthed important insights and established agreed-upon models to help answer these questions, this research base is extensive, complex, and often not honored by the design of traditional schools. To that end, our *Designing for Learning Primer* aims to summarize the essence of what's known about how learning happens in a way that is digestible and actionable.

Factors

Key influences in how learning happens, including cognition, motivation, identity, and individual variability.

Principles

Critical findings related to each factor regarding how people best learn.

Implications

Conditions learning environments should strive to create and design choices with the potential to support these conditions.



This primer is not meant to be a fully comprehensive review of the literature. Instead, it is an introduction to four key factors that impact learning—cognition, motivation, identity, and individual variability. We chose to focus on these factors because a wealth of research indicates that each is critical to how learning happens. Using this research, we developed a set of core principles that help explain the role each factor plays. In addition, we identified various implications for learning environments. Within the discussion of these implications, we've included examples of specific design decisions that honor each principle. These decisions relate to curriculum, assessment, scheduling, adult roles, and more. However, we also recognize that the specific context a learning environment is situated in will greatly influence these decisions. As a result, these examples are meant to be illustrative only.

How This Resource Complements Others

This is not the first attempt to pull together research on how learning happens. In fact, many rich, science-informed resources exist across the field. Below are just a few that significantly inform this primer; additional resources we reviewed are listed throughout the primer, as well as in the works cited list.

Building Blocks for Learning | Brooke Stafford-Brizard with Turnaround for Children
Breakthrough Leadership in the Digital Age: Using Learning Science to Reboot Schooling
 | Frederick M. Hess and Bror V. H. Saxberg
Drivers of Human Development: How Relationships and Context Shape Learning and Development | David Osher, Pamela Cantor, Juliette Berg, Lily Steyer, and Todd Rose
Foundations for Young Adult Success | Jenny Nagaoka, Camille A. Farrington, Stacy B. Ehrlich, and Ryan D. Heath
The Evidence Base for How We Learn | Stephanie M. Jones and Jennifer Kahn with the Aspen Institute's National Commission on Social, Emotional, and Academic Learning
Learn Better: Mastering the Skills for Success in Life, Business, and School, or, How to Become an Expert in Just About Anything | Ulrich Boser
Malleability, Plasticity, and Individuality: How Children Learn and Develop in Context | Pamela Cantor, David Osher, Juliette Berg, Lily Steyer, and Todd Rose
The Science of Learning | Deans for Impact
The Science of Summit | Summit Public Schools

The goal of our resource is to complement this exciting and growing body of knowledge in a way that supports whole-school design. To that end, we brought together research on multiple factors that impact learning, looking beyond the cognitive aspects of learning to consider motivation, the role of identity, and how individual variability comes into play. We also applied a school design lens that considers not just classroom-based instruction, but also the role of adults, schedules, partnerships with the community, and more.

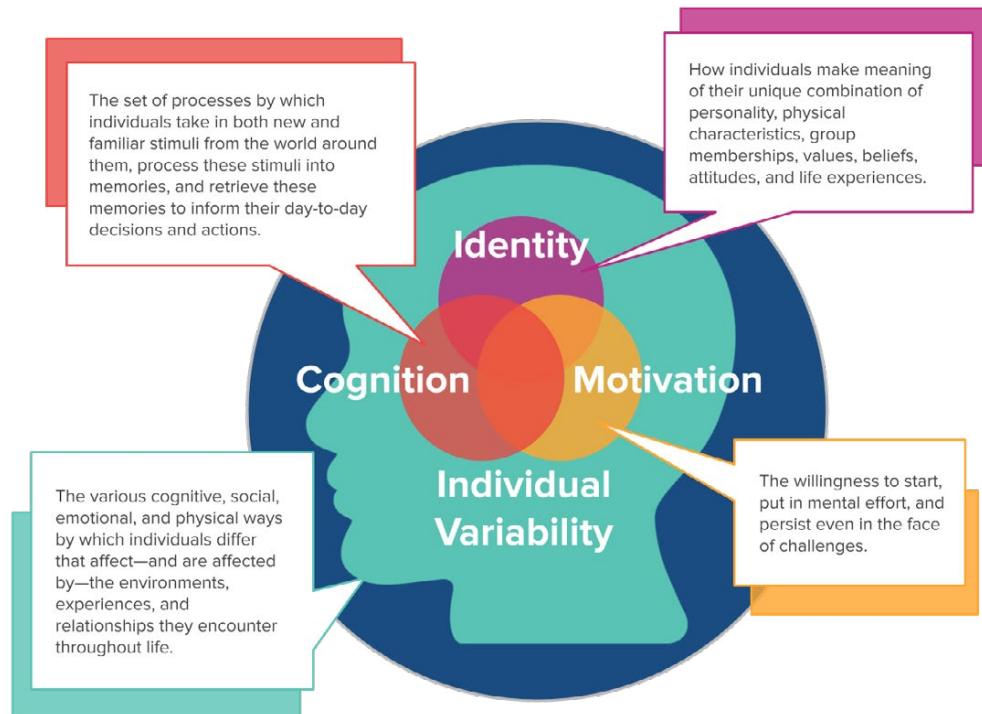
As mentioned above, we stop short of prescribing specific design choices (e.g., how to design schedules, curricula, technology platforms, etc.) since these are so context-specific and since the empirical evidence on the efficacy of specific design choices is thinner to date. In place of specific recommendations, we've developed a supplementary tool—our *Designing for Learning Cards*. These cards, and the activities that accompany them, are intended to help designers deepen their understanding of how learning best occurs and make design choices that adhere to the research, but that also make sense for their unique context.

You can [download a free printable version](#) of the *Designing for Learning Cards* or [buy professionally printed cards](#). You can also hover your phone's camera over the QR code to the right to access these links and resources.



Our Framework for Learning

This primer focuses on four factors that impact learning—cognition, motivation, identity, and individual variability.



Cognition

Cognition refers to the set of processes by which learners take in new stimuli, process these stimuli into memories, and retrieve these memories to deploy in future actions. These processes occur through a relationship between working memory (sometimes called short-term memory) and long-term memory. When learners become conscious of new sensory stimuli, their own passing thoughts, or even past memories, they are held in working memory where learners can grapple with them, connect them to what they already know, and apply them. In making meaning of them, learners encode new memories into long-term memory—where a virtually infinite number of memories can be stored. These memories are the basis of learning. They can relate to knowledge (e.g., retrieving information about the Civil War or the Pythagorean Theorem), skills (e.g., writing a compelling essay or navigating conflict with peers), and even mindsets (e.g., thinking optimistically or holding a growth mindset). While this process may sound straightforward, it can break down if key principles of learning are not honored. For example, if working memory is trying to make sense of too much at once, it can become overloaded and ineffective.

We'll explore these concepts more in the Cognition section on pages 18–37. Specifically, we'll dive into the science behind the six principles listed below as well as into how we can honor these principles in our learning environments.

Focused Attention

People learn best when they direct their focus toward the content and experiences most relevant to learning.

Manageable Cognitive Load

People learn best when they are challenged but are processing a manageable amount in their working memory.

Meaningful Encoding

People learn best when new learning is experienced in memorable ways and is related to prior knowledge.

Effective Practice

People learn best when they practice challenging-but-doable skills at frequent, focused intervals and across diverse contexts.

High-Quality Feedback

People learn best when they receive timely and targeted feedback to guide their improvement.

Metacognitive Thinking

People learn best when they are able to plan, observe, evaluate, and adjust their own learning processes.

Motivation

While we believe that young people are naturally motivated to learn, it is still hard work. Just ask anyone who has practiced scales on a musical instrument for hours each day! Tasks like paying attention, engaging in focused practice, and taking in critical feedback require real effort. As a result, motivation—or the willingness to start, put in mental effort, and persist—is vital if learners are to engage in challenging cognitive tasks.

Research has found that various factors influence a learner's motivation, and when present, can support learning and development. Here, we've highlighted four factors that influence motivation: (1) whether or not the learner finds value in the learning, relationships, or the process; (2) the extent to which the learner feels self-efficacy—or a belief in his or her ability to complete the learning tasks; (3) the learner's sense of control over the process and outcomes of learning; and (4) the extent to which the learner is in a constructive emotional state while learning. Of course, what learners value, their confidence in their own abilities, the barriers they perceive, and their emotional state are all deeply affected by their unique background knowledge, identity, physical and cognitive differences, lived experiences, and more. As a result, motivation is deeply intertwined with cognition, identity, and individual variability.

In the Motivation section on pages 38-47 we'll dive into the science behind the four principles listed below and their general implications for the design of learning environments.

Value

People learn best when they find the content, outcomes, processes, and relationships associated with learning important and relevant.

Self-Efficacy

People learn best when they believe in their ability to grow and achieve mastery of what they are learning.

Sense of Control

People learn best when they perceive that they have meaningful and appropriate agency over their learning.

Constructive Emotions

People learn best when they are in constructive emotional states versus ones of excessive stress or anxiety.

Identity

Identity stems from how learners—and those around them—make meaning of their unique combinations of personality traits, physical characteristics, group memberships, values, beliefs, attitudes, and life experiences. An individual can simultaneously hold a racial identity, a cultural identity, gender identity, religious identity, and family role identity, among others. Identity is also not static; it evolves over time. Learners' identities are one of the main determinants of what motivates them to engage in tough cognitive work. So developing self-understanding—including knowledge of one's personal history, strengths, areas for growth, and interests—helps learners understand what they value and what they need to feel motivated. Learners' identities can impact learning in ways other than their influence on motivation. For example, if an identity that a learner perceives as positive is triggered, that identity marker can make it easier to understand a concept and/or free up space in working memory to engage in a task. Conversely, if an identity that a learner perceives as negative is triggered, this may bring to the surface feelings of inadequacy and insecurity, dramatically hindering cognitive processes.

We'll explore these concepts more in the Identity section on pages 48-59. There, we'll dive into the science behind the three principles related to identity listed below.

Self-Understanding

People learn best when they have a deep understanding of who they are and can use this knowledge to maximize their learning.

Sense of Belonging

People learn best when they feel connected to, as well as accepted by, the people and environment around them.

Navigating Identity Threats

People learn best when negative beliefs associated with their identity are minimized or buffered against.

Individual Variability

Young people vary along many dimensions—including their physical attributes, prior knowledge, cognitive processing, affect, developmental state, exposure to adversity, and so many other factors. In fact, the science of individuality suggests that there is no such thing as the “average” learner!¹ Thus, the more learning environments can account for how young people vary, the more successful they will be in supporting their learning.

These differences are critical given how they intersect with identity, motivation, and cognition. For example, different experiences or capacities may influence how learners come to understand themselves in relation to the world around them, leading to a more positive or negative sense of identity. This identity subsequently influences one’s levels of motivation. Some elements of individual variability require specific learning modes in order to optimize cognitive processes. For example, to support learners who are blind, Braille literacy instruction can be provided. Matching instructional modes to individuals’ needs makes it much easier for learners to effectively engage in cognitive processes.

We’ll explore these concepts more in the Individual Variability section on pages 60-72.

Life Experiences

People learn best when their unique life advantages and adversities are understood and responded to.

Developmental State

People learn best when their experiences align with where they are developmentally.

Learning Differences

People learn best when their unique learning needs are identified and resources and supports are aligned with these needs.

Common Themes

It's important to note that a few common themes cut across the sections of this primer.

Learning is a deeply individual and variable process.

The principles explored in this primer apply to how everyone learns: young people and adults, typically and atypically developing learners. However, the specific ways these principles interact to influence learning vary for each individual. The Individual Variability section touches on this in the most detail; however, individual variability impacts nearly all of the other principles. Everything from whether one's working memory becomes overloaded in a specific context, to what one finds value in, to what might trigger an identity threat, will vary from learner to learner.

Emotions play an important role in many parts of learning.

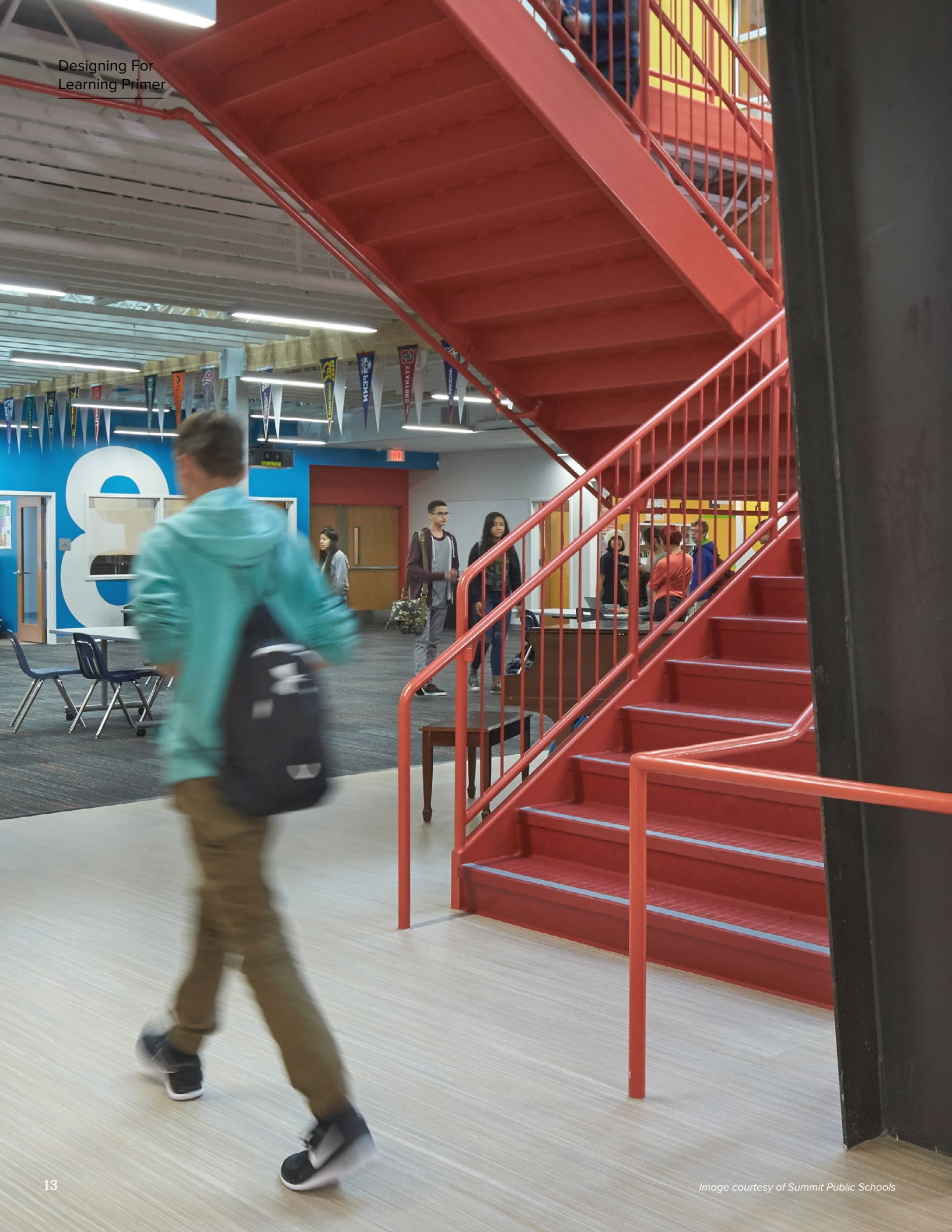
Emotions work hand in hand with cognition to enable or impede learning. Emotions can distract, motivate, and be powerful cues to help remember information later. As a result, you'll notice references to the influence of emotions on learning.




Social connections support deeper learning.

As you read, notice how these themes are woven into the principles of learning and their implications for learning environments.

As you'll see in the pages that follow, research suggests that secure relationships, a sense of community, and collaboration can all positively impact learning. How this occurs is complicated. For example, sometimes relationships provide a buffer against traumatic life experiences, identity threats, or low self-efficacy. Other times, they provide a greater sense of value and motivation. Similarly, working collaboratively might lead to constructive emotions for learners but can also support meaningful encoding and lasting learning.





The following sections go into more detail about the influence of cognition, motivation, identity, and individual variability on learning. Each section starts with a short overview of one factor. It then describes the role each principle plays in learning and some implications for the design of learning environments suggested by the principle.

You may decide to break this primer apart and focus on specific factors, or even principles, in isolation. This can make the complex ideas within it more manageable and allow you to focus on specific factors and principles.

However, it's critical to keep in mind that all the ideas in it are important and that they interact in complex ways to support or hinder learning. As a result, focusing exclusively on one part will not give you the complete picture and will not enable you to optimize learning.

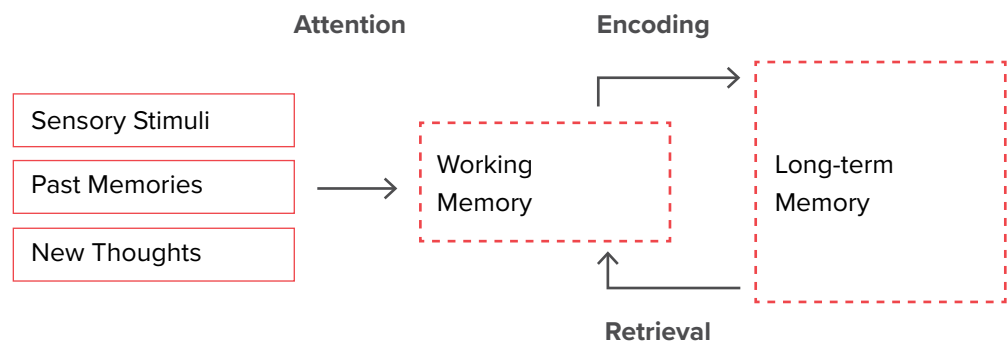
Ultimately, you should develop an understanding of all the ideas in this primer and work to design learning environments that strike a balance between factors.



Cognition

Overview

Learning is hard work. It requires that individuals actively notice, grapple with, remember, apply, and expand on new content and experiences. This involves complex cognitive processes like attention, encoding, and retrieval that occur through a relationship between working memory and long-term memory.



As the visual above shows, when learners consciously attend to something—whether it's new sensory stimuli, passing thoughts, or past memories—it is held in working memory. This is where learners grapple with ideas, make connections, generate understanding, and solve problems. These processes help learners encode information into long-term memory in meaningful and memorable ways. Then, by regularly engaging in practice, receiving high-quality feedback, and thinking about their own thinking, learning becomes even deeper and longer-lasting.

As designers, we can support this process by creating environments that honor the principles listed on the next page.



Focused Attention

People learn best when they direct their focus toward the content and experiences most relevant to learning.

Manageable Cognitive Load

People learn best when they are challenged but are processing a manageable amount in their working memory.

Meaningful Encoding

People learn best when new learning is experienced in memorable ways and is related to prior knowledge.

Effective Practice

People learn best when they practice challenging-but-doable skills at frequent, focused intervals and across diverse contexts.

High-Quality Feedback

People learn best when they receive timely and targeted feedback to guide their improvement.

Metacognitive Thinking

People learn best when they are able to plan, observe, evaluate, and adjust their own learning processes.



Focused Attention

How It Works

PRINCIPLE

People learn best when they direct their focus toward the content and experiences most relevant to learning.

Individuals are always learning. The mind continually confronts stimuli from all kinds of sources. These stimuli include sights, sounds, smells, tastes, or feelings stemming from new experiences. They also include spontaneous thoughts that are remembered (“Shoot, I needed to bring money for lunch today!”) or that develop in the moment (“I think she’s talking about me behind my back”). What learners attend to—or direct their focused attention toward—is held within working memory where it can be grappled with, made meaning of, or applied to accomplish a goal, whereas most of what learners do not pay attention to is simply forgotten.^{2 3}

Ideally, learners would attend to the stimuli most critical to learning. However, they may also attend to stimuli that are counterproductive to, or distract from, learning. What learners attend to depends on many factors, including how salient information is to their goals and interests as well as to their physical and emotional needs.^{4 5} In addition, research suggests there is a hierarchy when it comes to how individuals process stimuli. Higher-priority stimuli override lower-priority stimuli.⁶ This research indicates that the brain processes stimuli that pose a threat first (“I hear a siren getting closer”), followed by stimuli that generate strong emotions (“The character in this book reminds me of a terrible argument I had with my sister”), followed by goal-related stimuli (“I need to understand this concept to create a great experiment”).⁷

We can’t force learners to focus. However, we can remove or minimize distractions caused by physical or psychological threats, confusion, and competing sensory stimuli.

Implications for Learning Environments

Learning environments should be designed to tend to any feelings of physical or psychological threat, inside or outside of school, because a learner’s cognition will attend to these first. These threats produce negative emotions that hijack a learner’s attention. However, emotional distractors are sometimes given less priority within learning environments than distractors like noise. This should not be the case. We can intentionally design against emotional distractors by developing policies and routines that ensure our facilities are warm and secure. Example routines could include having adults check for a learner’s emotional state at the door each morning or having a calming breakfast among peers to diffuse negative emotions versus a large group breakfast in a busy cafeteria. In addition, our curriculum could integrate contemplative practices to help learners manage stress. We could also develop additional adult roles

² Sousa, 2016

³ Ibid.

⁴ Ibid.

⁵ Katsuki & Constantindis, 2013

⁶ Sousa, 2016

⁷ Ibid.

or create partnerships with community organizations to ensure learners have access to health and wellness resources inside or outside the learning environment. We can also ensure educators and administrators are well equipped to identify a learner's emotional state and help manage it.

Next, we must design against distractions resulting from confusing and overly complex learning objectives or learning activities. When this happens, learners are unsure where to direct their focus and may attend to the wrong content or engage in a task in the wrong way. To prevent this, we can ensure that curricula and other instructional materials are clear and organized. We can also ensure that adults have the knowledge and skills to communicate ideas to learners clearly and to design logical learning experiences.

Finally, we can address sensory distractions like excess noise, poor lighting, or even uncomfortable temperatures by designing physical spaces and

facilities with good acoustics, considering the quality and brightness of lights, and ensuring rooms have temperature control whenever possible. We can also create community-wide routines and policies that foster a sufficiently calm environment without being overly restrictive, and grant flexibility with these routines and policies when needed.

To support Focused Attention, learning environments should:

- Help learners feel physically and psychologically safe and healthy
- Ensure that learning objectives and activities are clear
- Minimize sensory distractions
- Provide consistency

Additional Resources

Focus: The Hidden Driver of Excellence | Daniel Goleman

Strategies for Getting and Keeping the Brain's Attention | Edutopia



Manageable Cognitive Load

How It Works

PRINCIPLE

People learn best when they are challenged but are processing a manageable amount in their working memory.

Working memory is used to temporarily hold content and experiences important to learning. It's also where conscious thinking happens. Unfortunately, working memory is fragile and easily overwhelmed. In adults, working memory can hold only approximately three to five pieces of information at once and can retain the information for only seconds or minutes. In children and adolescents, this number is more like three or four chunks of information. In toddlers, working memory's capacity is even more limited; it can hold only approximately one or two chunks of information at once.⁸ When cognitive load—the amount being held and grappled with in working memory at any one time—is too large, learners lose the ability to process new information. In fact, it's actually surprisingly easy for learners (especially those who are novices) to experience cognitive overload. This can occur when learners have to hold or process too many new things at once. It can also happen when working memory is forced to do extraneous processing that does not support the instructional objectives—factors such as hunger, stress, threats to identity, strong emotions, or lingering thoughts from past situations.

What is manageable for working memory varies across individuals and across contexts.⁹ In other words, what is manageable for one learner may overwhelm another, even if they are a similar age and in the same learning environment. This is not typically because working memory itself is weaker or stronger across individuals—although neurodevelopmental differences like ADHD can diminish working memory—but because of learners' different emotional and physical states, as well as the relevant knowledge and expertise they already hold. In some cases, emotional and physical states may lead learners to have competing thoughts (“I feel like I don’t fit in here” or “I’m incredibly hungry”). In other cases, a learner’s lack of prior knowledge may increase cognitive load by forcing the learner to grapple with additional ideas that are beyond the scope of the learning objectives but are not yet held in long-term memory.

The latter example highlights the importance of prior knowledge to future learning—a finding backed by extensive research.¹⁰ ¹¹ Having prior knowledge or relevant existing expertise allows a learner to manage the concepts and tasks at hand more quickly and effortlessly and to grapple with new learning. This is because some automated processing can be done by long-term memory.¹² For example, a reader who is automatically able to decode words and read with fluency has more capacity in working memory to focus on comprehension.

8 Ibid.

9 Willingham, 2008

10 Tobias, 1984

11 Lui, Grady & Moscovitch, 2016

12 Sweller, 2011

Implications for Learning Environments

If learners are grappling with more than their working memory can manage, they are unlikely to learn effectively. To prevent this, learning environments must continue managing distractions, organize learning objectives and activities thoughtfully, and support each learner to achieve competency in tailored ways.

While focus helps individuals attend to the content and experiences essential to learning, ensuring a manageable cognitive load helps them process the content and experiences. In both cases, minimizing distractions is critical. This is because distractors can compete for limited working-memory capacity even if a learner is attempting to focus. This again reinforces how important it is to help learners feel physically and emotionally safe by designing secure facilities, ensuring learners are supported by caring adults, and creating ways for learners to practice self-management as well as to access additional resources and support when needed.

Preventing cognitive overload also has implications for how content and experiences are organized.¹³ First, learning should be broken into manageable chunks and logically sequenced to support future learning. In addition, experiences should minimize confusion and extraneous processing. For example, when multiple modalities—such as visuals, text, and sound—are all used at once, these modalities should complement each other instead of competing with each other since processing competing information can unnecessarily occupy a learner’s limited working-memory capacity.¹⁴

^{15 16} To accomplish this, we can hire and train educators who have the knowledge and skills needed to design clear and organized curricula, learning activities, and materials. Alternatively, pre-designed curricula can free educators up to spend more time working with learners. Either way, as these resources are developed, we’ll need to ask tough questions like: How many standards can we really expect a learner to “master”? And how much time do learners realistically need to reach mastery? Minimizing distractions

should push us to reflect on other parts of our designs too. For example, we should consider how much thinking our physical spaces require learners to do, and whether that thinking supports learning or is a distraction. In many cases it may be helpful to develop some routine learning activities—such as using the same Socratic seminar format every Friday—to prevent learners from having to build understanding of new processes over and over.

Our designs should also empower educators and learners to adjust fluidly in response to individual readiness and should ensure each learner achieves competency with critical prerequisites before moving on. A competency-based and customized approach like this is very different from what schools traditionally do and thus requires new design choices. For example, this approach calls for a more robust and flexible curriculum than is typically the case today. This curriculum should allow learners to move through content in different ways and should have scaffolds embedded within it to support different learners, such as different representations of information, graphic organizers, worked examples, or adult or

To support Manageable Cognitive Load, learning environments should:

- Minimize cognitive and emotional distractors
- Break learning into manageable, logically sequenced increments
- Represent content and experiences clearly
- Respond to individual learner readiness with tailored supports and pacing
- Ensure that individual learners achieve competency with prerequisite objectives before they move on

13

Ibid.

14

Clark & Mayer, 2011

15

Tabbers, Martens & van Merriënboer, 2004

16

Tindall-Ford, Chandler & Sweller, 1997



Image courtesy of
Valor Collegiate Academies

peer support.^{17 18} Assessment practices will also need to shift from being primarily whole-group activities that occur at single, fixed intervals, to being available on demand to individual learners as they work through learning objectives and until they achieve

competency with those objectives. Lastly, because learning requires ongoing retrieval, the curriculum and assessments must consider how best to spiral and revisit content over time.

17 Deans for Impact, 2015
18 Vygotsky, 1978

Additional Resources

Combating Cognitive Load | Sanford Inspire

Cognitive Load Theory | MindTools

Information and Cognitive Overload: How Much is Too Much? | Richard L. Byyny



Meaningful Encoding

How It Works

PRINCIPLE

People learn best when new learning is experienced in memorable ways and is related to prior knowledge.

The limited processing capacity of working memory means long-term memory is critical for lasting learning. Long-term memory is the mind's deep storage space. The knowledge, skills, and mindsets in long-term memory are retrieved and get applied to material in working memory to guide decisions and actions. When complex tasks such as driving or reading are practiced sufficiently, they become automated by long-term memory. The knowledge and skills stored in long-term memory free up capacity within working memory to grapple with new topics and ideas. Luckily, long-term memory is both broad and deep, holding a vast number of memories and retaining them for months, years, or even a lifetime. However, storing new learning in long-term memory requires that individuals successfully encode it first. Encoding is the process of taking in information and then relating it to what's already known. Research suggests the basic goals when encoding new learning should be to make the initial intake of content and experiences distinctive—or unique and memorable—and to create organizing schemas that connect and relate different content and experiences.¹⁹

A memory can be made more distinctive through elements of the context that are present when the memory is first made—like sights and smells—as well as a learner's emotional state at the time. This is why moments associated with strong emotions like anger or awe are more likely to be remembered later. It is also why certain images or scents can trigger vivid memories. These memories are often referred to as flashbulb memories.²⁰ However, emotions like anxiety and fear can also embed negative experiences, and the beliefs and mindsets associated with them, into learners' long-term memory. This is one reason adverse childhood experiences (ACEs) can be so detrimental to development and learning—these experiences are embedded in long-term memory and may be triggered by sights, sounds, smells, feelings, or other contextual cues associated with the traumatic event.

Successful encoding also involves learners relating and building on ideas in ways that are logical and personally meaningful. This process is sometimes referred to as cognitive elaboration and involves connecting and grouping ideas into organizing schemas.²¹ The relationships learners establish through these organizing schemas may be factual ("This event happened before that one") or conceptual ("The core themes here are the same"). Organizing ideas into thematic categories, connecting visuals with written ideas, developing mnemonic devices, and outlining information are all ways learners commonly develop organizing schemas. Research suggests that the importance of cognitive elaboration is likely part of the reason why generating one's own understanding of a topic can be so impactful.²² It is also why having related prior knowledge helps to

¹⁹ Sweller, 1988

²⁰ Hunt, 2003

²¹ Klein & Loftus, 1988

²² Schmidt, 1983

accelerate future learning—prior knowledge provides something for new learning to be related to.^{23 24} This increases the likelihood that the new learning will be remembered.²⁵ Continually expanding prior knowledge enables long-term memory to grow exponentially—the more that is stored in it, the easier it is to keep adding and the more complex ideas can be.

Implications for Learning Environments

Encoding content and experiences into long-term memory effectively must be a priority; otherwise, what young people learn will not last. We can support this by making the actual experience of learning memorable, as well as by helping young people connect what they are learning to what is already in their long-term memory.

We can make the experience of learning more memorable by designing activities and contexts that inspire emotions like wonder, surprise, and even purposeful anger, as well as by building sensorily rich (though not overwhelming) environments. Our designs can achieve this by, for example, connecting learning to topics that young people feel wildly angry or curious about, integrating hands-on learning experiences that appeal to learners' senses into the curriculum, or varying the physical space within which learning happens in purposeful ways. Collaborative learning can also foster positive emotions, plus it provides learners with a context to explain, compare, evaluate, and revise their understandings, leading to improved organizing schemas. However, these actions must be done in a way that supports learning goals versus just introducing new stimuli that might distract learners from the task at hand.

Once we design memorable processes and contexts for learning, we can work to help young people build rich organizing schemas for what they learn. These organizing schemas are created when learners make factual and conceptual connections between different things they are learning. For example, a learner might see a cause-and-effect relationship between two historical events or a similar theme across two novels. They are also created when learners connect new learning to their prior knowledge and experiences. Generating one's own understanding of a topic is a powerful way to support the development of organizing schemas because it requires learners to unpack relationships

23

Tobias, 1994

24

Lui, Grady & Moscovitch, 2016

25

Klein & Loftus, 1988





and use prior knowledge to make meaning of something new. Hands-on, discovery-based learning is one pedagogical approach that supports this. However, it also requires us to make hard decisions about pacing to ensure all learners have sufficient time to really grapple with tough concepts. Without sufficient time, learners may struggle to achieve competency with the knowledge and skills they will need to support subsequent learning. Unfortunately, many adults are not trained to facilitate the type of learning that supports meaningful encoding. They may feel uncomfortable letting young people grapple with ideas themselves versus providing them with the answers. Or they may not be well versed in asking questions to deepen understanding or in providing appropriate scaffolds. Luckily, we can account for many of these barriers if we are proactive with our designs.

To support Meaningful Encoding, learning environments should:

- Promote distinctive or emotionally compelling learning experiences
- Connect new learning to learners' prior knowledge and experiences
- Help learners make underlying factual and conceptual connections
- Integrate multiple representations of content through different modalities, problem types, and contexts

Additional Resources

Creating Multi-sensory Experiences to Improve Memory Retention | Sanford Inspire
Engaging Emotions to Improve Memory Retention | Sanford Inspire

Dual Coding | The Learning Scientists

Organizing Information to Improve Memory Retention | Sanford Inspire

Elaboration | **The Learning Scientists**
Concrete Examples | The Learning Scientists

What Works, What Doesn't | John Dunlosky, Katherine A. Rawson, Elizabeth J. Marsh, Mitchell J. Nathan, and Daniel T. Willingham



Effective Practice

PRINCIPLE

People learn best when they practice challenging-but-doable skills at frequent, focused intervals and across diverse contexts.

How It Works

Even if new memories are initially encoded into long-term memory, they may be forgotten without effective practice. Practice ensures a learner is engaging in retrieval—the process of drawing stored memories back into one’s working memory to apply them. Retrieval itself helps to more deeply “wire patterns and processes into long-term memory”²⁶ and makes learning long-lasting.²⁷ Individuals engage in retrieval all the time: a simple example might be thinking repeatedly about a favorite scene from a movie. In learning environments, research suggests various characteristics make practice more effective and enhance retrieval. Specifically, practice should be:

- **Purposeful**—Goal-oriented practice consciously devoted to achieving a specific, well-defined goal or skill that is important for a learner to achieve.²⁸
- **Rigorous**—Practicing at the edge of one’s “comfort zone” just beyond what is automatic for the learner so it is doable, yet challenging.²⁹
- **Spaced**—Practicing in multiple sessions distributed over time versus all at once.³⁰
- **Interleaved**—Mixing up, or weaving together, practice with related topics through different types of problems that require different strategies.
- **Across Contexts**—Practicing across diverse, authentic contexts to support transfer.³¹
- **Frequent and Focused**—Practicing at routine intervals that are brief enough to ensure 100% focus.^{32 33}

As these characteristics demonstrate, effective practice does not entail “cramming” or rote practice of the same types of problems over and over. These forms of practice may help a learner remember something for a short time, but the learning will not be as long-lasting as it would be with more effective forms of practice.³⁴

Implications for Learning Environments

Learning environments must know what individual learners need to practice, as well as provide a sufficient number of well-designed opportunities to do so.

Understanding the current proficiency level of each learner is essential to designing impactful practice. If practice is focused on skills learners have already mastered, or the level is not matched to their current skill level, then it will not help learners improve.

26 Hess & Saxberg, 2014, p. 41
27 Melton, 1963
28 Ericsson & Pool, 2016
29 Ibid
30 Hess & Saxberg, 2014
31 Kirschner & van Merriënboer, 2008
32 Willingham, 2004
33 Ericsson & Pool, 2016
34 Ibid

However, few schools have systems that allow them to understand each learner's proficiency in a comprehensive way, such as on-demand, formative assessment systems or competency-based approaches to grading.

Our environments need to provide sufficient opportunities for effective forms of practice. As discussed earlier, this means practice is frequent, but spaced out; short enough to ensure learners can devote their complete focus to practicing; woven together—or interleaved—so learners are applying different but related skills and working through various types of problems; and occurring across different contexts and disciplines. Achieving this can be tough. Traditional school designs sometimes foster a sense of urgency and an inclination to push forward in the curriculum instead of building in more opportunities for practice. In addition, content areas are often very siloed from each other, making transdisciplinary practice rare. In addition, many adults are not deeply trained in the science of effective practice, making it hard for them to design for it. To combat this, our designs should purposefully consider the knowledge, skills, and mindsets adults need to support effective practice and work to build them. They should also consider ways to integrate more interdisciplinary work as well as ways to ensure the

schedule and pace of learning provides sufficient time for practice.

Finally, for learners to become more self-directed, it's critical for them to understand the importance of practice and to know what effective practice does and does not look like. We can support this by building a culture of practice and explicitly teaching learners about the science of practice, just like we teach the adults who support them.

To support Effective Practice, learning environments should:

- Use each learner's current proficiency to plan opportunities for practice
- Provide learners with ongoing opportunities to engage in focused, frequent practice, across diverse contexts
- Build learners' own understanding of effective practice

Additional Resources

Retrieval Practice Library & Downloads | [RetrievalPractice.Org](https://retrievalpractice.org)

Spaced Practice | The Learning Scientists

Interleaving | The Learning Scientists

Retrieval Practice | The Learning Scientists

Strengthening the Student Toolbox | American Educator

Expert Practice | Character Lab



High-Quality Feedback

PRINCIPLE

People learn best when they receive timely and targeted feedback to guide their improvement.

How It Works

Practice alone is not enough; in order to optimize learning, it must be coupled with targeted feedback. Targeted feedback helps address misconceptions and guides further practice. However, not all feedback is equally effective for supporting learning. Feedback should be:

- **Specific and Accurate**—Feedback should accurately communicate specific aspects of performance relative to specific goals.³⁵
- **Process- and Outcome-Focused**—Feedback about both the process and the outcome of learning is helpful. Learners need to know whether the strategies they're using to complete a task are appropriate and whether they're meeting performance standards.³⁶
- **Elaborative**—Feedback should explain a learner's performance and how improvements can be made versus just providing a summary of what was correct and incorrect or a single grade.³⁷
- **Timely**—Ideally, feedback should be provided soon after practice and with sufficient time for learners to correct misunderstandings and practice more. However, even feedback delivered much later can be helpful if it is followed by additional opportunities to practice.³⁸

Implications for Learning Environments

High-quality feedback helps learners correct misunderstandings and chart a path forward. Our learning environments can support this by building learners' understanding of the goals they are working toward, integrating sufficient and well-placed opportunities for feedback into the schedule, and ensuring the content of feedback will help a learner improve.

Feedback will be less meaningful if learners do not know the goals they are working toward and what success looks like. As a result, our curricula and instructional approaches should clearly communicate the learning objectives. In addition, learners should have access to exemplars against which they can compare their own work as a form of self-reflective feedback.

As described above, for feedback to drive learning it must be provided when learners still have an opportunity to improve after receiving it. This requires thoughtful scheduling, so that educators can review work, formulate feedback, and provide that feedback to learners before it is irrelevant. It may also require new ways of allocating

35 Ambrose et al., 2010
36 Hattie & Timperley, 2007
37 Ambrose et al., 2010
38 Ibid.

adults' time and using space so that adults can provide feedback in small groups or one-to-one versus trying to do so in large groups. The importance of timely feedback also suggests a need to shift away from using only large summative projects and exams to assess learner progress toward more bite-sized checks for understanding that can provide more timely and formative feedback.

The content of feedback is also incredibly important. For feedback to drive learning, it needs to focus on the process of learning and how a learner can improve versus only focusing on one's current level of achievement. It is hard, if not impossible, to give this type of feedback without deep understanding of what is being learned, how people typically learn it, and common misconceptions that occur along the way. Some learning environments are tackling the very real challenge of giving high-quality feedback to many students by using adaptive technologies to help young people understand what they got wrong and why; other schools have tutoring systems where specialists are assigned to a small group of learners to give them more time and feedback on a specific

subject. Schools that use a lot of manipulatives may have feedback built into the materials themselves. For example, consider a learner who is putting a square block into a triangular slot: this material—given the way it is designed—provides the learner immediate feedback that squares and triangles are not the same shape.

To support High-Quality Feedback, learning environments should:

- Build learners' understanding of what success looks like
- Offer sufficient, timely opportunities for giving and receiving feedback so that learners can improve
- Ensure feedback provides a sufficient and accurate analysis of a learner's progress as well as guidance for improvement

Additional Resources

Delivering Effective Feedback | Sanford Inspire

5 Research-Based Tips for Providing Students with Meaningful Feedback | Edutopia



Metacognitive Thinking

How It Works

PRINCIPLE

People learn best when they are able to plan, observe, evaluate, and adjust their own learning processes.

While feedback from adults and peers can effectively support learning, as young people progress through their education and lives they will need to take greater responsibility for their learning. To do this, learners need to develop metacognitive thinking skills—or the ability to think about their own thinking.^{39 40} When applying metacognitive skills, learners engage in a variety of processes to monitor and control their own learning.⁴¹ These processes include assessing the demands of a task, evaluating their knowledge and skills, planning their approach, monitoring their progress, and adjusting their strategies as needed.⁴² Metacognitive thinking is a powerful driver of learning. Research suggests that it increases one's ability to transfer learning to different contexts because it supports a higher level of understanding that extends beyond the specific task or subject area.⁴³

However, metacognitive thinking is challenging, particularly for learners with cognitive load issues stemming from grappling with a lot of new content or managing negative emotional states. Luckily, research suggests that just like other skills, metacognition can be developed through instruction, practice, and feedback focused on skills like goal setting, planning, and assessing progress.^{44 45} In fact, simply asking learners to explain why they got something correct or incorrect or how well they believe they understand a certain concept or skill can push them toward thinking more metacognitively. Research also suggests that metacognitive skills are more likely to develop in learners who believe that intelligence is malleable and that learning requires effort. Finally, research on brain development suggests that metacognitive thinking skills also tend to deepen as learners get older and executive functions develop further, especially throughout adolescence and young adulthood.⁴⁶ This does not mean young learners can't engage in metacognitive thinking by, for example, identifying learning strategies they used or exploring why they got an answer wrong; it simply suggests increasingly complex metacognitive work should be asked of older learners.

Implications for Learning Environments

Learners should receive explicit instruction on goal setting, planning, reflecting on progress, and making adjustments, and they should have opportunities to apply these skills across different contexts. To support this, we can make creative choices about how time is used. For example, our schedules could include 30 minutes each week for

- 39 Ibid.
- 40 Bransford, Brown, & Cocking, 2000
- 41 Zimmerman, 2001
- 42 Ambrose et al., 2010
- 43 Bransford, Brown, & Cocking, 2000
- 44 Ambrose et al., 2010
- 45 Tanner, 2012
- 46 Ambrose et al., 2010

young people to reflect on the learning strategies they're using, their progress, and what to do next. This time could be further maximized by using it as an opportunity for feedback or relationship building as well. Alternatively, we could train educators to include more metacognitive practice alongside the learning young people are already doing. This can be as simple as adding a self-reflection component to existing assignments, projects, and exams that asks learners to recount the learning strategies they used, challenges they faced, and how much they believe they learned.

One especially critical understanding we want to build in our learners is that their thinking does not happen in a vacuum. Instead, it is impacted by a lot of different factors. These factors include their own personal values and beliefs, but also larger societal messages that may be shaping learners' thinking. These messages may be empowering or threatening. Either way, they are often very subtle, yet they can have a great impact on learners' belief in themselves.

The development of a "culture grounded in metacognition" is also helpful.⁴⁷ In such an environment, everyone is open about their own learning, including the processes they are using and

47 Tanner, 2012

the progress they are making. To support this, we can ensure our instructional approach and schedule provides learners with opportunities to voice confusion and ask clarifying questions. Additionally, we can ensure adults are transparent about their own confusion and model their use of metacognitive skills.

To support Metacognitive Thinking, learning environments should:

- Make the skills and mindsets that support metacognitive thinking explicit learning objectives
- Help learners understand how different beliefs and messages may be impacting their thinking
- Ensure opportunities for learners to apply metacognitive thinking strategies across all learning contexts
- Develop a culture in which thinking about one's thinking is the norm

Additional Resources

Boosting Metacognition and Executive Functions in the Classroom | The Learning Scientists

How to Improve Your Metacognition and Why It Matters | The Learning Scientists

Metacognition | Vanderbilt University

Metacognition and Self-Regulation | Education Endowment Foundation

Metacognition: How Thinking About Thinking Can Help Kids | Child Mind Institute

Self Regulation Graduate Aims Entry | Transcend

That's So Meta(cognitive) | Smithsonian Science Education Center



Motivation

Overview

Despite learners' natural curiosity, the hard work of learning requires motivation—the willingness to start, put in mental effort, and persist. This is especially true in the face of challenges.^{48 49} For example, learners don't usually do loads of focused practice for enjoyment—it's challenging and may not be much fun. Motivation helps learners get through. Motivation is personal; what motivates someone and how motivated they are by a particular task varies from person to person, context to context, and even from time to time.⁵⁰ However, research that looked across many studies of motivation has found four main factors that can drive or block motivation: value, self-efficacy, a sense of control, and constructive emotions.⁵¹

Since nothing happens without motivation, one of our central goals as designers should be to support motivation with each learner, whether this means sustaining learners' natural curiosity and motivation, helping to expand on it, or removing barriers to it. We can do this by honoring the principles listed on the next page.

48 Headden & McKay, 2015

49 Ormrod, 2014

50 Ryan & Deci, 2000

51 Clark & Saxberg, 2018



Value

PRINCIPLE

People learn best when they find the content, outcomes, processes, and relationships associated with learning important and relevant.

How It Works

Motivation flows when learners perceive that what they are learning has value to them. This value may spring from the relationship a learner has with what is being learned, how they are learning it, who they are learning it with, or why it is being learned.⁵² In other words, a learner might feel that a task has value because it's fun ("I value the excitement of this science experiment"), because of its relevance to family or community ("I value learning about diabetes because I can better support my dad's battle with high blood sugar"), because of who is around when it's being completed ("I value doing this with friends who are counting on me"), or because it is a required step on the way to achieving a future goal ("I value this geometry lesson because I want to be an architect"). What is perceived as valuable, and in turn motivating, also changes as learners develop. For example, research suggests young children are highly motivated by relationships with parents and other caregivers, like educators. On the other hand, adolescents are increasingly motivated by their relationships with peers and by social perceptions.^{53 54}

Value may also stem from a desire to achieve certain outcomes or rewards. These rewards are sometimes extrinsic, which isn't necessarily a bad thing. However, research cautions that working toward a major goal for an extrinsic reward over time tends to reduce any intrinsic motivation learners initially felt for a task. So using rewards or incentives—be it grades, treats, or points—should be done carefully.⁵⁵ One way to do this is by using extrinsic rewards to incentivize smaller steps when learners are working toward something big that they find intrinsically interesting. Note that common extrinsic rewards can be challenging because the rewards that are meaningful to one person may be meaningless to another.

Implications for Learning Environments

When learners see value in their learning, they are more intrinsically motivated. Our environments can support this by making the process and goals of learning feel relevant and compelling, as well as by using extrinsic motivators with care.

Research suggests a few ways to make learning more relevant and interesting to young people. For example, learners' identities can be taken into account when planning in order to align content and experiences to their interests, goals, and prior knowledge from the start. We can also help learners make these connections themselves with any learning activity, even ones not explicitly designed with their identities in mind. This can be done by providing learners with an opportunity to explain how what they are learning

52 Ryan & Deci, 2000
53 Wigfield & Wagner, 2005
54 Yeager, Lee & Dahl, 2017
55 Ryan & Deci, 2000

is relevant to their lives.⁵⁶ Another powerful strategy is to provide learners with opportunities to shape their own learning process so they can increase the relevance themselves.⁵⁷ Finally, we can leverage the social aspect of learning and provide opportunities for young people to interact with those they have meaningful relationships with. We can make learning more relevant to young people via specific design choices like focusing on project-based learning, using authentic assessment, integrating real-world internships, offering a diversity of electives, or fostering collaboration. We can also ensure the adults in our environments deeply understand the learners they work with and demonstrate cultural competence.

Fostering value through the intrinsically motivating practices described above should be a priority; however, there may also be times when extrinsic motivators can increase the value of learning too.

56 Hulleman, Godes, & Harackiewicz, 2007
57 Clark & Saxberg, 2018

Examples of using extrinsic motivators carefully include giving learners badges or small prizes to mark their progress toward a bigger, personally meaningful goal.

To support Value, learning environments should:

- Ensure that what is being learned feels relevant to the interests and goals of all learners
- Ensure how learning occurs feels compelling to learners
- Enable learners to work with peers and adults with whom they have meaningful relationships
- Use extrinsic rewards only sparingly and support progress toward intrinsically motivating goals

Additional Resources

Be the Spark: Nurturing Student Inspiration | Sanford Inspire

Building Connections | Character Lab

Differentiation Strategy: Student Choice | Sanford Inspire

Helping Students “Want” to Achieve | Sanford Inspire

Student Motivational Theory: “I Can” and “I Want” | Sanford Inspire



Self-Efficacy

How It Works

PRINCIPLE

People learn best when they believe in their ability to grow and achieve mastery of what they are learning.

Another way that motivation is built and sustained is through self-efficacy, or the belief in one's innate ability to achieve a goal.⁵⁸ Like all factors that influence motivation, self-efficacy is context and task specific, so learners might feel they can handle algebra but not writing or history. This is because it is a function of self-held beliefs regarding one's ability ("I'm just not a computer person") as well as beliefs about any broad social identities that may be cued in the moment ("Asians are good at math and science"). Developmental factors also influence a learner's self-efficacy. For example, beliefs regarding one's ability to succeed are often higher in young children and can be shaken during adolescence.

To feel efficacious, learners need to believe they have the knowledge and skills to be successful at learning something. These beliefs are built up by experiencing prior success following hard work. Like anything, with repeated practice, these beliefs become cemented in long-term memory. Once there, the beliefs can be cued and retrieved into working memory to enhance self-efficacy, provide motivation, inform behavior, and drive learning. It is important to note that learners may also have memories of failure that lead to a diminished sense of self-efficacy and decreased motivation to learn.

Implications for Learning Environments

It is hard for a learner to be motivated if they don't believe they can succeed. As a result, our learning environment should enable all learners to experience wins, help them develop skills and mindsets that support a belief in themselves, and ensure they have a supportive adult to reach out to when their beliefs are shaken.

Self-efficacy increases when learners experience the connection between hard work and success. For this to happen, the goals learners are working toward need to be challenging—so that learners are doing real work—but also achievable with effort and supports. Learners also need to understand their progress and have multiple opportunities to improve. Using a competency-based or mastery-based approach to instruction, grading, and learner progression is one way to design in support of self-efficacy. Having adaptive curricula, likely supported by high-quality technology, can also help give young people content that is appropriate for where they are academically, so they can be both challenged and set up for success. School grading policies that allow learners to redo assignments and improve grades can also support self-efficacy. Such policies signal to learners that their effort really counts and that there is no such thing as getting things completely right the first time around.

58 Bandura, 1982

Learners are also better prepared to achieve goals if they are planning, setting goals, breaking the task into smaller pieces, and assessing progress at regular intervals—in other words, if they are engaging in rigorous metacognitive thinking. Of course, there will also be times when learners really struggle, so our learning environments need to be places where difficulties are seen as a normal part of learning that can be overcome with the right resources, support, effort, and strategies. The language educators use is incredibly important here. For example, research suggests that praising learners more for effort and process instead of outcomes better supports self-efficacy.⁵⁹ However, research also warns that this praise should be sincere and earned. If learners receive praise for work they judge to be mediocre, they may interpret this as a signal that they can't do any better or that mediocrity is an acceptable outcome.⁶⁰ In addition, eliminating negative talk about learners' abilities from adults' language and correcting learners when they engage in negative self-talk can also support self-efficacy. A specific

example is changing “I can't do this” to “I can't do this yet.” In addition, it's helpful to ensure each learner has someone they trust, or someone who is similar to them and has successfully achieved the goal they are struggling with.⁶¹ ⁶²This all has big implications for how we define adults' roles as well as how we hire and train adults.

To support Self-Efficacy, learning environments should:

- Engage learners in tasks that are challenging but doable
- Help learners regularly set goals, plan toward them, and reflect on progress
- Frame failure as a temporary state that can be changed by changing one's behavior
- Ensure that learners have trusted adults they can seek help from when they feel insecure about their abilities

59 Willingham, 2005

60 Ibid.

61 Clark & Saxberg, 2018

62 Hulleman, Godes & Harackiewicz, 2007

Additional Resources

Growth Mindset Lesson Plan | Khan Academy

Mindset Kit | Mindset Kit

Helping Students Believe They “Can” Achieve | Sanford Inspire

Student Motivational Theory: “I Can” and “I Want” | Sanford Inspire

Examples of Constructive Praise and Encouraging Comments | Daniel T. Willingham



Sense of Control

How It Works

PRINCIPLE

People learn best when they perceive that they have meaningful and appropriate agency over their learning.

When learners have a sense of control over their learning, they believe they can impact both how they learn and the success they achieve. They see ways to shape the goals they are working toward and how they achieve them to make them more meaningful, enjoyable, or impactful. They also see their performance as a matter of their own effort that is not hindered by things outside their control like a lack of time, insufficient resources, or unsupportive adults. On the other hand, when learners lack a sense of control over their learning, they see no ways to shape the learning process to better suit them or may believe that barriers beyond their control are preventing their success. When this happens, a learner may exert less effort and quit more easily.⁶³

63 Dweck, 2006



Implications for Learning Environments

Since owning your learning is motivating, our environments should create conditions that support it and remove barriers that prevent it.

First, our environments should provide learners with an appropriate level of decision-making power so they can shape their own goals and the processes used to achieve them. This could, for example, take the form of learners choosing the specific topics they will research or how they will demonstrate what they learned. Guardrails are important here, especially for novices. This is because novices may experience cognitive overload when presented with too much choice or if they are still developing the self-awareness, metacognitive skills, or understanding of the learning objectives needed to make a choice. We can put guardrails in place by providing learners with a menu of high-quality choices versus giving them free rein.

Learners need to feel the choices they make and the hard work they put in will pay off in the near and long term, and that factors beyond their control will not compromise their learning. This has critical implications for everything from our budget and operations to the physical spaces we create to

the capacity of the adults we hire, and more. For example, our budgeting and operational decisions have the potential to either inhibit or ensure learners' access to the materials and technology needed for learning. Similarly, our physical spaces can either be too crowded, noisy, and hot or they can be spacious and comfortable, and educators can either be capable and motivated or lack critical expertise and disengage. Learning environments can also enable and support learners in becoming self-advocates who speak up and hunt for solutions when they feel they don't have the support needed to succeed.

To support Sense of Control, learning environments should:

- Provide appropriate autonomy over when, where, or how learning is pursued
- Help learners attain the supports and resources needed to achieve their goals
- Minimize external barriers to learning

Additional Resources

GripTape Agency Framework | GripTape

Agency Graduate Aims Entry | Transcend

The Key Benefits of Choice from Learning to Choose, Choosing to Learn | Mike Anderson



Constructive Emotions

How It Works

PRINCIPLE

People learn best when they are in constructive emotional states versus ones of excessive stress or anxiety.

A learner's emotional state directly impacts motivation. Some emotional states are constructive when one is trying to learn; for example, joy is a powerful emotion that supports lasting learning in positive ways.⁶⁴ However, if learners are in an emotional state marked by negative feelings such as anxiety, fear, or depression, it can damage motivation. A negative emotional state may result from the breakdown of other drivers of motivation like sense of control ("It wasn't my fault I failed; the teacher didn't teach me enough, and now I'm angry"), self-efficacy, ("I just don't feel like I can do this work"), or value ("I'll never use what I'm learning so who cares"). It can also be caused by something occurring outside the learning environment such as family struggles or conflicts with friends. It is important to keep in mind that emotions are also deeply individual, so some learners may experience a negative, unconstructive emotional state while others remain positive in the same situation. This may be a result of differences in prior experiences involving such situations. Similarly, emotions may fluctuate throughout development, and even over the course of a day. They are very context dependent.

Implications for Learning Environments

Motivating learning environments help learners achieve constructive emotional states—this could mean working to alleviate things like stress and anxiety, channeling anger into productive action, or experiencing joy while learning.

In order to create constructive emotional states, our environments should be warm and joyous spaces where learners have positive relationships with their peers and adults. We can do this through community-building routines such as advisory groups, restorative practices, circles, or mentorships. We can also create physically welcoming spaces that showcase learners' lives and accomplishments and feel inviting.

Our environments should also support constructive emotions by supporting learners' physical and mental health. This includes making operational and scheduling decisions that ensure learners have access to healthy food while at school, can attain a good night's sleep, and get sufficient opportunities to be active. We can also help learners manage negative emotional states by integrating contemplative practices like mindfulness and other emotion-regulation strategies into our curriculum. In some instances, taking action may also be an effective way to channel emotions that may otherwise be unconstructive, such as anger or sadness. In these cases, enabling learners to engage in projects or take other productive action can be restorative and support learning. However, we should not expect learners to always manage negative, unconstructive emotions on their own. Instead, we should create environments that ensure learners who need physical and psychological services to tackle tough problems

have access to them. We can ensure learners and their families have access to mental health services by expanding the services our environment provides through community partnerships or by hiring for different roles.

Additional Resources

Retrieval Practice Library & Downloads |
RetrievalPractice.Org

Spaced Practice | The Learning Scientists

Interleaving | The Learning Scientists

Retrieval Practice | The Learning Scientists

Strengthening the Student Toolbox | American Educator

Expert Practice | Character Lab

To support Constructive Emotions, learning environments should:

- Be warm and joyful spaces
- Foster positive relationships between peers, as well as between adults and learners
- Support physical and psychological health and well-being
- Help learners diffuse negative emotional states

*Image courtesy of
Concourse Village Elementary School*





Identity

Overview

Learners' identities stem from how they make meaning of their unique combination of personalities, physical characteristics, group memberships, values, beliefs, attitudes, life experiences, and more. Individuals who understand and act in alignment with their values, interests, and goals tend to live happier, healthier, and more successful lives.⁶⁵ Having a secure sense of identity and self-understanding can also support learning because it informs what a learner determines is valuable to learn, fosters energy and constructive emotions, and supports metacognitive thinking.⁶⁶ ⁶⁷When identities that are incongruent with academic success are cued within learners' minds, it can be demotivating and prevent learning. As designers, it's our role to create environments where learners are able to explore questions of identity, express who they are, feel affirmed, and reconceive themselves as individuals capable of learning and success.

As a result, grappling with questions of identity is a critical developmental task. However, it also takes real cognitive effort, and learning environments must be built to account for this. This can be supported by honoring the principles on the following page.

65 Damon, 2008
66 Demetriou, 2000
67 Damon, 2008



Self-Understanding

People learn best when they have a deep understanding of who they are and can use this knowledge to maximize their learning.

Sense of Belonging

People learn best when they feel connected to, and accepted by, the people and environment around them.

Navigating Identity Threats

People learn best when negative beliefs associated with their identity are minimized or buffered against.



Self- Understanding

How It Works

PRINCIPLE

People learn best when they have a deep understanding of who they are and can use this knowledge to maximize their learning.

Learners can hold various identities simultaneously. These include current identities (“I’m a good learner”) and possible future identities (“I want to be a doctor”), as well as personal identities (“I make really funny jokes”) and broad group identities (“I am Native American”). These identities evolve over time through a process of exploration (“How do I like to dress?”, “What privileges do I carry?”), commitment (“I want to wear baggy clothing”, “My whiteness gives me privileges”), and re-exploration (“Should I keep dressing this way now that I have this job?”, “What biases am I noticing in myself?”)⁶⁸ This process takes real cognitive effort as working memory grapples with past memories, current experiences, emotions, others’ reactions, and more. If learners do not have the dedicated time and mental space to take on identity development and change, it will happen regardless, but in ways that may compete with other learning goals.

Identity development becomes particularly relevant in adolescence, when identity formation is the key developmental task.^{69 70} Young people question their former assumptions about identity, engage in in-depth exploration of various aspects of themselves, and take action to commit to important identity markers.⁷¹ During this time, adolescents tend to demonstrate many different identities that vary based on the social context. An individual may dress, speak, and behave one way with family, another with friends, and yet another when alone. Learners’ broad social identities—including their racial, ethnic, and gender identities—also become more salient during adolescence, and many learners become especially vigilant to ensure role conformity for themselves and others, especially when around peers.⁷² Ideally, as learners develop a deeper understanding of their talents, interests, and desires, they move away from this state of multiple, evolving, and possibly divergent identities to a more secure, integrated identity that is positive and supportive of success.⁷³

While a learner’s individual developmental state impacts identity formation, so do other elements of individual variability like the social groups a learner is a part of. For example, research suggests that identity development differs for white versus black versus biracial learners, for men and women, and for individuals in different countries.^{74 75} The existence of inequity, how learners come to recognize (or not recognize) this, and its impact on them are key drivers of differences in how identity develops.⁷⁶ In American society,

- 68 Marcia, 1966
- 69 Erickson, 1972
- 70 Meeus, Iedema, Helsen & Vollebergh, 1999
- 71 Klimstra et al., 2010
- 72 Steinberg & Morris, 2001
- 73 Nagaoka et al., 2005
- 74 Kroger, 2017
- 75 Tatum, 1992
- 76 Ibid.

members of more dominant, privileged groups (e.g., whites, males, heterosexuals, members of dominant religions, able-bodied, middle or upper class, etc.) are often “the standard against which everyone else is measured.”⁷⁷ As a result, individuals from traditionally

oppressed groups may feel less than, as if they do not belong, or as if their own identities are not represented.

Implications for Learning Environments

Our learning environments should help learners explore and commit to both current and future identities, while also ensuring learners have space to re-explore and recommit as they develop and change.

We can start by providing learners with opportunities to deeply explore where they come from and opportunities to engage with new people, contexts, and activities that they may not otherwise encounter. This will help learners make important discoveries about themselves and the world around them. We

can design for this by bringing learners’ cultures into both what they are learning and how they are learning it. Learners should also have opportunities to think, talk, and write about their life stories, heritage, family, and community, so they can explore the impact each has had on them.⁷⁸ All of this has implications for the curriculum we design and pedagogical approaches we use with young people. In designing each, we should think about how to partner with members of the local community, learners, and families to ensure learning is authentic and relevant. Our environments

77 Kimmel, 2016

78 McAdams, 2001

*Image courtesy of
Valor Collegiate Academies*





should also provide learners with opportunities to engage with new people, contexts, and activities that they may not otherwise encounter. We can do this by building intentionally diverse communities, creating an extensive network of partnerships that extend learning well beyond school walls into other contexts around the world, or designing the curriculum with a deliberately global perspective.

Learners also need opportunities to commit to elements of their current and future identities, bridge gaps between who they are now and who they want to be in the future, and re-evaluate parts of who they are as they learn and develop. As a result, our environments should support learners in expressing and living into their identities. To accomplish this we can, for example, integrate personal narratives and storytelling activities into the curriculum. We can also provide opportunities for learners to shape the learning process to help them achieve their desired future identities. Research suggests contemplative practices like mindful breathing, visualization, and journaling foster this type of self-reflection and self-awareness, as does honest feedback from individuals who know learners well.⁷⁹

79 Davidson & Kaszniak, 2015

To support Self-Understanding, learning environments should:

- Deepen learners' understanding of their life story, heritage, and community
- Help learners identify and reflect on their strengths and areas for growth
- Immerse learners in new contexts and activities
- Offer opportunities for learners to express their various changing identities
- Help learners reflect on their current identities, desired future identities, and how best to bridge the two

Additional Resources

Self-Awareness Graduate Aims Entry | Transcend

Sense of Purpose Graduate Aims Entry | Transcend

Summary of Stages of Racial Identity Formation | Racial Equity Tools



Sense of Belonging

How It Works

PRINCIPLE

People learn best when they feel connected to, as well as accepted by, the people and environment around them.

The need for social belonging is “a basic human motivation.”⁸⁰ When learners feel like they belong in their school community, it helps to affirm and strengthen their identity, can be a source of motivation, and supports learning. More specifically, research indicates that learners with a positive sense of belonging engage in fewer problem behaviors, are more open to feedback, take advantage of educational opportunities at a higher rate, have more positive attitudes, experience less depression, and stay in school.^{81 82} Conversely, learners who question their belonging are less likely to demonstrate these positive outcomes and are more vigilant to cues from the environment related to their identity and whether they fit in. This makes them more apt to experience identity threats, which can occupy working memory and impede learning. Research also demonstrates that learners from underrepresented and traditionally oppressed groups are generally those most likely to question their belonging within learning environments. Taken together, the importance and challenges of fostering belonging has powerful implications for learning and equity.

80 Walton & Cohen, 2007, p. 82
81 OECD, 2017
82 Romero, 2017

Image courtesy of Ednovate



Implications for Learning Environments

As designers, it's our job to create and maintain environments where all learners feel like they belong to a larger community by making them feel welcomed, heard, and accepted.

We can help learners feel welcome by creating environments that are relevant to, and celebratory of, their identities. For example, we can ensure learners' identities are represented in the broader staff and peer population. We can construct a physical environment with art or other objects from their community. We can infuse the curriculum with books written by individuals who share important identity markers with learners. We can develop routines that reflect culturally relevant practices. We can also help learners feel welcome by normalizing feelings of self-doubt. Adults can help by openly and honestly modeling their own moments of insecurity. Other role models, like older peers, could do the same.

In addition to feeling welcomed, learners should also feel heard and respected. We can do this by providing all learners with opportunities to contribute to important community-wide decisions. For example, learners can be involved in defining community norms, decorating the physical space, or planning events. In addition, policies and practices should ensure learners are treated fairly and guard against feelings of shame that may arise when a learner must receive different supports because of an individual difference.

83 Mallet, 2015

In addition to these proactive ways of building a sense of belonging across a community, we must also actively work to rebuild this atmosphere during difficult moments. Restorative practices and circles can be helpful in these moments. These routines and policies are not at odds with having consequences for breaches; rather, they enable learners to work through mistakes in a way that is grounded in reflection, trust, and support. These practices can prevent feelings of shame and disengagement, as well as the disruptive behaviors which are associated with more exclusionary discipline practices like suspensions and expulsions.⁸³

To support Sense of Belonging, learning environments should:

- Be relevant to and celebrate learners' identities
- Provide all learners with opportunities to be heard and encourage participation
- Hold high expectations for all learners
- Help learners understand that self-doubt happens to everyone
- Minimize zero-tolerance and utilize restorative practices to re-establish trust and connectedness

Additional Resources

Linking Identity & Achievement through Cultural Competence | Sanford Inspire

Teachers as Agents of Change | Sanford Inspire

Weekly Circles for Students and Faculty | Edutopia and Valor Collegiate



Navigating Identity Threats

How It Works

PRINCIPLE

People learn best when negative beliefs associated with their identity are minimized or buffered against.

Our identities are a lens for viewing the world. When learners interpret a task as congruent with their identity—because it should be doable or important to “people like them”—they are more likely to do it. This is especially true when the tasks are difficult. The tricky thing is that people have many identities, not all of which are active at a given moment. To influence motivation, an identity must be present in working memory at that time. Broad social identities like race, gender, and ethnicity are often “psychologically salient.”⁸⁴ Therefore, they are likely to be cued by a wide range of situations, and are more likely to be cued than narrow individual identity markers, such as one’s identity as an artist or scientist. For some learners, these broad social identities can disrupt their ability to learn and experience success because of identity threats.

Take, for example, what research tells us about stereotype threat. Stereotype threat refers to the “tension that arises in members of a stereotyped group when they fear being judged according to these stereotypes.”⁸⁵ Studies have found that simply calling attention to an individual’s membership in a stereotyped group is enough to bring that identity to mind and activate negative stereotypes.⁸⁶ Research also shows that stereotype threat negatively impacts performance, regardless of a person’s ability, their level of preparation or self-confidence, or even their belief in the stereotype itself.⁸⁷ Stereotype threat has this impact because it adds to learners’ cognitive load: once certain stereotypes have been activated, learners will expend mental energy reacting to the perceived threat through anger, rumination, disengagement, or added vigilance to the setting.⁸⁸ This diverts attention and working memory away from the task at hand. Unfortunately, these stereotypes can be activated by seemingly innocuous comments and can affect children as young as five years old.⁸⁹ The risk of stereotype threat can present an added hurdle for learners who are already struggling to overcome other disadvantages associated with poverty, sexism, or racism.⁹⁰ Stereotype threat isn’t the only type of identity threat that has an impact on learning. Impostor syndrome is another example, and it can make learners feel exposed; in *Whistling Vivaldi*, Claude Steele vividly describes his experience as the only black student in a PhD program where “excellence seemed to have an identity [linked to whiteness] which I didn’t entirely have and worried that I couldn’t get.”⁹¹

84 Oyserman & Destin, 2010. p. 1010

85 Ambrose et al., 201

86 Ibid.

87 Ibid.

88 Steele, 2011

89 Ibid.

90 Ibid.

91 Ibid., p. 153

Implications for Learning Environments

As designers, we can counteract identity threats by cueing identities that motivate learning, challenging the narrative about broad social identities that have been stigmatized and helping learners fight against inequality.

Learners' visions of their future selves can provide motivation, and learning environments should tap into this. We can do this by ensuring that learners—particularly learners from traditionally oppressed groups—regularly reflect on their vision for their future selves, articulate strategies for attaining these visions, and discuss what might get in their way.⁹² Once learners have these identities clear in their minds, we should ensure that content and learning experiences are relevant and that this relevance is apparent to learners. This requires thoughtful curriculum design and skillful facilitation of learning by adults.

Since learners also have broad social identities that are easily cued and sometimes carry stereotypes, our environment should be designed to minimize actions, words, or images that might lead a learner to think about and internalize these biases. This will require us to build adults' understanding of diversity, equity, and inclusion topics and practices. It will also require us to consider everything from the pictures in—or not in—books that young people read to cultural practices we honor through our community building routines.

Finally, even with our best efforts, many learners will still experience bias. Building all learners' understanding of systems of oppression and privilege can prevent learners from wrongly blaming

themselves for these negative events as well as prevent learners from perpetuating them.⁹³ In addition, providing learners with opportunities to act against these systems can build a sense of empowerment. Developing affinity groups can create a safe space to dig into these topics. And again—since representation matters—it's also helpful for learners to encounter examples of people who are like them and who are happy and successful. At times, learners may also benefit from contemplative practices that support deeper self-awareness and counteract trauma. All of this will require curriculum and scheduling decisions that prioritize social justice, the development of critical consciousness, and mindfulness practices.

To support Effective Practice, learning environments should:

- Cue learners' motivating identities over identities that may trigger stereotypes or self-doubt
- Minimize actions, words, or images that may trigger negative self-perceptions
- Expose learners to individuals who have countered identity threats
- Help learners understand and act against systemic inequity and personal experiences of bias

92 Oyserman & Destin, 2010
93 Steele, Spencer & Aronson, 2002

Additional Resources

Empirically Validated Strategies to Reduce Stereotype Threat | Stanford University

Critical Consciousness Graduate Aims Entry | Transcend



Individual Variability

Overview

Learners differ in all kinds of deeply intertwined ways. These include differences in cognitive processing, emotion, background knowledge, interests, personality, physical abilities, exposure to trauma, and cultural values, among others. These differences impact identity development, motivation, cognitive processing, and, in turn, learning. Often, schools have not recognized these differences, viewed them as deficits, or not been designed to respond well to them. Instead, many schools have been designed around the mythical concept of “the average learner.”⁹⁴ When a school is designed for the average learner, it takes a “one size fits all” approach that may not be best for learning. For example, learners may be engaging in practices that are too easy or too hard based on prior mastery, or they may not see the personal relevance and value in the tasks they are engaged in.

A core challenge for our design process is to find creative ways to ensure that learners’ individual profiles are deeply understood and responded to by the surrounding learning environment. We can do this by honoring the principles on the next page.

94 Rose, 2016



Life Experiences

How It Works

PRINCIPLE

People learn best when their unique life advantages and adversities are understood and responded to.

An individual's life experiences are critical to development. In fact, much of the biological diversity in individuals stems from their earliest life experiences, some of which occur before birth. These experiences “are built into our bodies, creating biological ‘memories’ that shape development, for better or for worse.”⁹⁵ These early experiences include the relationships infants and young children form with caregivers, the environments that surround them, the nutrition they receive, and more. These early experiences can be advantageous—secure and positive attachments with caregivers, environments free of toxins, eating healthy foods and activities like sleep and exercise—or they can be adverse—neglectful or abusive relationships, exposure to traumatic events or pollution, and highly processed or inadequate food.⁹⁶ The relative advantage or disadvantage a learner faces, especially in developmentally sensitive periods, lays the foundation for mental and physical health later in life.

While all learners experience both advantageous and adverse life experiences, powerful systems of privilege and oppression also create patterns of greater adversity for some and greater advantage for others. For example, racism and economic inequality lead learners of color and those in poverty to be impacted by chronic adversity at a statistically higher rate than white learners and more economically-advantaged learners.⁹⁷ Adverse childhood experiences (ACEs) can have an especially harmful impact on learning. Examples of ACEs include exposure to poverty, emotional or physical abuse, the death of a close family member, or a parent being incarcerated. Additionally, learners who identify or are identified as part of a traditionally oppressed group based on their gender, race, ethnicity, religion, age, ability, sexual orientation, or other marker may regularly deal with microaggressions, stereotyping, and bias.

The pervasive nature of these experiences can be toxic to cognitive, socioemotional, and physical development. More specifically, prolonged stress from sustained exposure to trauma can actually disrupt the development of the brain and other organs, leading to greater risks of certain diseases.⁹⁸ It has also been shown to impact one's sense of identity in harmful ways, leading to negative emotional states, leaving individuals feeling less efficacious and in control, and prompting excessive rumination that distracts from learning.⁹⁹ Over time, this can result in tangibly different life outcomes for a child. For example, research indicates that young people who experience six or more ACEs struggle more with learning and even have shorter lifespans.¹⁰⁰ However, facing a manageable level of adversity while surrounded by supportive relationships may actually result in more positive outcomes—like greater resilience when confronting challenges—

95 Center on the Developing Child, 2010

96 Ibid.

97 Wade, Shea, Rubin & Wood, 2014

98 Center on the Developing Child, n.d.

99 Osher, Cantor, Berg, Steyer & Rose, 2018

100 Ibid.

than not facing any adversity at all.^{101 102 103}In these scenarios, the adversity provides a learning opportunity while the supportive relationships provide a buffer against stress, thereby helping learners build critical skills such as planning, monitoring, and regulating behavior, and adapting to changing circumstances.¹⁰⁴

The buffering effect of positive relationships demonstrates one way in which relationships can be “a positive developmental force between children and their physical and social context.”¹⁰⁵ Research also suggests that healthy relationships

build a foundation for lifelong learning; promote adaptability; help integrate social, emotional, and cognitive processes; and, over time, actually change our genetic make-up.¹⁰⁶ Additionally, some research suggests that supportive relationships may have an even more positive impact on low-income learners.¹⁰⁷ While there is no consensus within research on what constitutes a healthy developmental relationship, important characteristics include attunement with, and ability to respond to, a learner’s emotions and needs, working together to complete tasks, compassionate communication, high expectations, consistency, trust, and cognitive stimulation.¹⁰⁸

Implications for Learning Environments

Learning environments must be responsive to the fact that each learner carries “a backpack filled with very different experiences.”¹⁰⁹ This requires that all learners are deeply known within their learning environments, that they receive support to heal from past adversity as well as buffer against ongoing adversity, and that their families and communities are engaged as assets in the learning process.

Knowing what all learners carry in their unique “backpacks” requires a deeper understanding of each learner than many learning environments currently hold. In other words, it requires us to go beyond knowing learners’ current levels of academic proficiency and diagnosed learning needs to understanding the backgrounds they come from, environments they’ve developed in, and how they make meaning of their various life experiences. We can make design decisions that help educators develop this deep understanding. For example, we can build routines and policies that enable caregivers to communicate with adults in the learning environment about their young people’s lives, such as open-door policies and consistent opportunities for conferences. We can also develop similar opportunities for learners themselves to communicate about their lives. We may also want to develop ways

to document learners’ varying life experiences to ensure all adults who support them fully understand a learner’s unique background. Technology-enabled learner profiles (when appropriate and with robust data security measures) are one way to accomplish this.

Next, it’s important that learners who face persistent or passing adversities receive responsive supports. Research suggests relationships with trusted adults, trauma-informed practices, and access to supplemental resources are all beneficial.¹¹⁰ To build these supports, we could develop unique mentoring roles for adults and then develop hiring practices or trainings to ensure adults have the knowledge, skills, and mindsets required to fill these roles. We may also choose to integrate relationship-building routines (e.g., check-ins with mentors) into the day, include stress-management strategies like mindfulness in the curriculum, or develop community partnerships with organizations that provide additional supports when our environments can’t. These supports may include physical and mental health services, job training and placement, or even a food pantry.

As we consider how to respond to individual learners’ life experiences, we should also recognize assets

101 Rutter, 2001.

102 DiAngelo, 2011.

103 Center on the Developing Child, 2007

104 Center on the Developing Child, 2010

105 Osher, Cantor, Berg, Steyer & Rose, 2018

106 Ibid.

107 Murray & Malmgren, 2005

108 Osher, Cantor, Berg, Steyer & Rose, 2018

109 Pape, n.d.

110 Osher, Cantor, Berg, Steyer & Rose, 2018



that exist in learners' home and community contexts and leverage these to support learning. These assets could include community centers, local artists, family members with special expertise in a topic young people are learning about, athletic coaches, and many more. In order to leverage these powerful assets, we might design a formal partnership with a local business to provide real-world learning opportunities and engage a community activist to work with learners. Some schools also formally invite family members and other important people from learners' lives to be parts of teams that support learners in defining goals, making plans to reach them, and evaluating their progress along the way. Identifying and incorporating these community assets should be a priority that receives operational and budgetary support.

To support Life Experiences, learning environments should:

- Understand the privileges and adversities that each learner carries
- Ensure that each learner is supported by a caring adult
- Use trauma-informed practices
- Provide or connect learners and families with non-academic resources and supports
- Leverage assets in learners' home and community contexts to support learning

Additional Resources

Understanding the Impact of Trauma on Students | Sanford Inspire

Understanding Anxiety in Children and Teens | Child Mind Institute

Supporting Trauma-Exposed Students | Sanford Inspire

Toxic Stress | Center for the Developing Child

Dream Teams in the Greenfield Model | Achievement First



Developmental State

How It Works

PRINCIPLE

People learn best when their experiences align with where they are developmentally.

Extensive research tells us that developmental changes matter a lot for identity development, motivation, and cognitive processing. While the literature on child development is robust and far too extensive to cover here, we can better design for learning by understanding some of the key physical, cognitive, emotional, and social shifts that occur. Below, these changes are grouped into three overlapping and fluidly defined life stages: early childhood, childhood, and adolescence. While research suggests “the shape of each child’s growth is unique and includes plateaus, reversals in direction, and stage-like jumps in development over time,”¹¹¹ these stages provide a general starting point to help understand a child’s developmental state.

Infancy and the earliest years of childhood are a highly sensitive developmental phase that significantly influences later outcomes.¹¹² Cognitive changes include the brain creating more than a million new connections every second. In fact, from birth to age two, the brain actually overproduces new connections. As a result, the brain is the most flexible (or “plastic”) during this time.¹¹³ The brain later “prunes”—or eliminates—connections that are not used. Forming attachments with caregivers is also a key developmental task during this time. These relationships are critical to socio-emotional development. Children rely on relationships to cope with stress and regulate emotions. Since young children learn through observation and imitation, these relationships also provide early models for learning. Together, all of this means that very young children’s brains are highly malleable and can be influenced in profound ways (positively and negatively) by their environments and relationships. This makes healthy life experiences particularly critical during early childhood.

When learners traditionally enter school, vast developmental differences are already apparent. They come into school at different points in their physical development. This includes differences in height and weight, but also in the extent to which they’ve developed gross and fine motor skills, balance, and endurance.¹¹⁴ Cognitively, learners’ brains are continuing to develop. One important finding is that their executive function skills—which support the ability to hold onto and work with information, focus thinking, and direct attention—have a window of opportunity for dramatic growth around ages three to five.¹¹⁵ Most young children also exhibit high levels of curiosity as they come able to grapple with more complex ideas and have new experiences they want to understand.¹¹⁶ Socially, children are beginning to form relationships outside their family and primary caregivers. These relationships provide learners with an opportunity to transfer critical interpersonal skills to new social interactions. Learners are also becoming

¹¹¹ Osher, Cantor, Berg, Steyer & Rose, 2018

¹¹² Davies, 2010

¹¹³ Center on the Developing Child, 2007

¹¹⁴ Davies, 2010

¹¹⁵ Center on the Developing Child, 2012

¹¹⁶ Davies, 2010

increasingly aware of themselves and how they compare to others.¹¹⁷

Adolescence is a critical developmental time for learners. Adolescent brains typically begin extensive “remodeling” that lasts into early adulthood. This process involves accelerated “pruning” as well as the strengthening of connections that are heavily used. This makes pathways in the brain more effective and efficient. The prefrontal cortex also further develops. This is the area responsible for the executive function skills mentioned earlier, as well as for complex processes like higher-order and metacognitive thinking. However, it is important to note that this area is not typically fully developed until one’s mid-twenties. As a result, teens often rely on other parts of their brains for decision making—particularly the amygdala, which is responsible for more immediate, emotion-driven reactions. The socio-emotional changes learners experience are closely intertwined with identity development which, as mentioned earlier,

is “the key developmental task” of adolescence.¹¹⁸

Learners work to explore the world and individualize themselves. Often, they begin to look to their peer group to set expectations for behavior and values instead of their family, as was the case in childhood. In exploring their identity, they also grapple with their sexual orientation and future career and life goals. Just like any other type of learning, this self-exploration takes real cognitive effort.

The above describes very broad trends across early childhood, childhood, and adolescence. However, it is critical to reiterate that the specific physical, cognitive, social, and emotional states of each learner, at any given point in development, will be unique. This means that all learners will be unique in the speed at which they move through each aspect of each phase.

117 Ibid.
118 Erickson, 1972

Image courtesy of
Concourse Village Elementary School





Implications for Learning Environments

Our learning environments should be aligned to general developmental trends while also being customized to each learner's developmental trajectories in ways that are well informed and empowering.

Designing in response to general developmental trends pushes us to consider what it might look like to create environments and experiences that support the key developmental tasks of different phases of life. For example, many young children are extremely curious since so much is new to them. As such, we should consider how we can honor this in our designs. We could do this by applying inquiry-based and project-based pedagogical approaches, for example. As another example, peer relationships are deeply important to most adolescent learners and can foster motivation but can also lead to unhealthy social comparisons and identity threats. We should consider how to ensure sufficient time for adolescents to socialize but also embed routines that foster healthy peer relationships.

Of course, not all learners develop to the same degree or at the same rate. Designing only for general developmental phases is insufficient—we also need to design environments that understand and respond to each individual's specific developmental state, or zone of proximal development.² Mixed-age classrooms are an example of a design choice that seeks to address both general developmental phases and learners' specific developmental states. Other design choices include flexible curriculum and on-demand assessment systems that allow learners to move fluidly through learning as they master different objectives, as well as flexible scheduling that allows

learners to move to different spaces based on their progress and needs. Responding to differences in development—like responding to differences in life experiences—will require tremendous shifts in the way we manage and share information. Using technology to manage this information and create meaningful profiles of all learners is one way to support this.

Finally, our learning environments should help learners understand and respond to their own development. This supports other key principles of learning such as self-understanding, sense of control, and metacognitive thinking, which in turn foster self-direction. We can do this by building learners' understanding of development and by designing ways for educators to communicate transparently with learners about their individual development.

To support Developmental State, learning environments should:

- Support key developmental tasks that occur across different phases of life
- Respond flexibly to reach all learners at their unique developmental zones physically, cognitively, socially, and emotionally
- Support learners in understanding and responding to their own development

2 Vygotsky, 1978

Additional Resources

Stages of Development and How Children Learn | Age of Montessori

The Zone of Proximal Development: An Affirmative Perspective in Teaching ELLs/MLLs | NYSED Office of Bilingual Education and World Languages 1

Let Learners Get in Their Zone (of Proximal Development) | EdSurge



Learning Differences

PRINCIPLE

People learn best when their unique learning needs are identified and resources and supports are aligned with these needs.

How It Works

There is extensive variability in how individuals learn. Some of this variability stems from life experiences or the developmental state a learner is in. However, other differences stem from variations in cognitive, social, and emotional traits and abilities. These are differences that may manifest in various ways as young people grow older, but likely will always be present in some way. While there is no single agreed-upon set of learning differences, many specialists break them into categories related to a learner's ability to read, write, work with numbers, focus attention, and engage executive functions. For example, dyslexia is a widely researched learning difference impacting reading abilities, while dyscalculia is a difference that impacts math abilities. The purpose of this section is not to give an overview of these various learning differences—that could be a book in and of itself. Instead, we want to highlight some general implications for learning environments and point readers toward additional resources.

Unfortunately, traditional school designs often do not fully account for the array of learning differences that exist. Instead, they tend to focus only on legally and medically defined differences. Other times, differences are viewed from a deficit perspective versus being seen as a normal part of human variability—or a source of strength. Autism is an often cited example. Traditionally, autism has been viewed as a disability that leads to repetitive behaviors and impairs social skills, speech, and nonverbal communication. However, scientists have come to understand (as many families have long known) that autistic individuals often also have advanced visual and spatial skills.¹¹⁹ Both these challenges and strengths have significant implications for how a child with autism best learns.

Implications for Learning Environments

As designers, we should strive to build environments that help educators understand and respond to differences in how each individual child learns while maintaining high expectations for all learners.

To accomplish this, our environments must, again, start by developing deep knowledge of each learner. In this case, that knowledge will focus on how each young person learns. Ensuring this knowledge exists for every learner embraces the idea that everyone can benefit from an individualized learning plan and transitions away from having structures, like individualized education programs (IEPs), for only some formally identified learners. As suggested above, these more robust “learner profiles” can give adults and learners a deeper understanding of the differences already discussed. To manage such a wide array of information at scale, high-quality learner information systems are needed and can be enabled by using technology thoughtfully and securely.

119 Silber, 2015.

Next, it's critical that learners' needs and strengths are not just known but understood and responded to. Principles from the Universal Design for Learning offer guidance in this area. This guidance focuses on integrating multiple ways to: 1) perceive new information; 2) navigate and express learning; and 3) maintain engagement.¹²⁰ Flexible sequencing of learning goals and flexible pacing for their completion can also facilitate learner engagement, motivation, and agency, as long as sufficient support and guidance are provided.

Finally, when learners are engaged in the same activities, scaffolds can be employed to reach young people at different readiness levels. It's important that we, as designers, develop systems and structures that support these instructional strategies and the flexibility they require. This will likely include a robust curriculum that learners can move through in different ways, a variety of assessment formats, and even assistive technologies—such as text-to-speech applications, assistive listening systems, and others—that can scaffold learning for young people with differing abilities.

Finally, it's critical that we not lower expectations in response to these learning differences. This means, for example, that all learners should be working toward, and assessed on, the same standards but with different supports and accommodations provided to some learners based on needs. In short, our operational decisions should ensure that resources

are allocated in a way that provides more to learners who need more. This includes providing learners who are struggling the most with the strongest educators. We can also make thoughtful decisions about scheduling that prevent learners from being excluded or having fewer opportunities because of their learning needs. And finally, our hiring and professional learning structures can ensure that the adults in our learning environments believe all learners can achieve at high levels.

To support Learning Differences, learning environments should:

- Ensure individual learners' needs and strengths are understood by adults and learners themselves
- Respond to differences by enabling learners to take in, engage with, and demonstrate learning in different ways
- Provide tailored scaffolds and supports in response to specific needs
- Maintain high standards for all learners, no matter their needs

120 CAST, 2008

Additional Resources

Universal Design for Learning | CAST

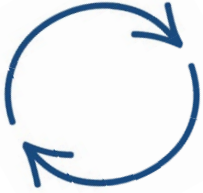
Agents of Their Own Success: Self-Advocacy Skills and Self-Determination for Students with Disabilities in the Era of Personalized Learning | National Center for Learning Disabilities

An Advocate's Guide to Transforming Special Education | Innovate Public Schools

Experience Personalized Tools | Understood.org

Conclusion

Exploration



Application

In this resource, we've explored how learning happens through a discussion of cognition, motivation, identity, and individual variability. While we hope the resource deepened your understanding of these topics, we also know that this is just the tip of the iceberg. Now it's time to take action by digging deeper into these ideas and applying them within your own community.

As mentioned in the introduction, our Designing for Learning Cards can help design teams apply the information in this primer. Each card states one of the 16 principles discussed above on the front and includes "How might we" questions aligned to the implications on the back. These cards are a tool for engaging in various design activities. We included two example activities with the cards linked above. The first activity explains a process for generating design ideas related to the various system elements above based on some or all of the 16 principles. The second walks you through an activity to analyze an existing or aspirational learning environment for some or all of the principles.

*Image courtesy of
Valor Collegiate Academies*

Explore More

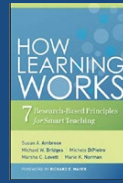
While any one of the principles we named could warrant a long paper in its own right, we hope the knowledge shared here will be a jumping-off point for further exploration. In other words, we hope you'll treat this resource not as the complete answer, but as an initial framework to guide deeper exploration. This is why we've included additional resources specific to each principle throughout the previous sections. On the next two pages you'll also find a list of books, research summaries, and frameworks that will deepen your general knowledge about learning and development. Finally, at the end of this conclusion, you'll find the full list of research we reviewed in order to create this primer.

As you continue your exploration, consider a few things about your process:

- **Who is involved**—Are the stakeholders most impacted by the decisions you're making—such as learners and families—included in the process? Are you ensuring your full community is well versed in all parts of the content, given that they are inextricably connected? Don't assume, for example, that cognitive principles are not relevant to physical education or that only the adults working with young people who have documented "disabilities" need to understand the role of learning differences.
- **How you break up the work**—Are you spreading out your exploration of learning science in ways that make it manageable and support learning? Will the pacing allow participants to experience a manageable cognitive load? Will it ensure they have space to make meaning and practice? One example of how you might consider breaking it up is to use this content as a "book study" for professional development.
- **What is the framing**—How are you presenting this work to your community? Is this framed as just an opportunity to learn? Or do those involved feel empowered to make real changes based on their new knowledge?

These considerations will help ensure the process is equitable and supports how learning happens, even for adults!

Books and Research



How Learning Works: 7 research-based principles for smart teaching

Susan A. Ambrose, Michael W. Bridges, Michele DiPietro, Marsha C. Lovett, Marie K. Norman



Learn Better: Mastering the skills for success in life, business, and school, or, how to become an expert in just about anything

Ulrich Boser



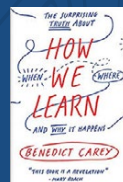
Make It Stick: The science of successful learning

Peter C. Brown, Henry L. Roediger III, Mark A. McDaniel



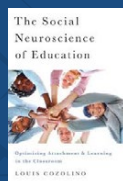
Malleability, Plasticity, and Individuality: How children learn and develop in context

Pamela Cantor, David Osher, Juliette Berg, Lily Steyer and Todd Rose



How We Learn: The surprising truth about when, where, and why it happens

Benedict Carey



The Social Neuroscience of Education

Louis Cozolino



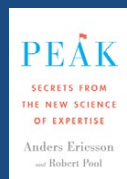
The Science of Learning

Deans for Impact



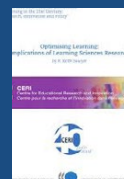
Drivers of Human Development: How relationships and context shape learning and development

David Osher, Pamela Cantor, Juliette Berg, Lily Steyer and Todd Rose



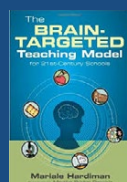
Peak: Secrets from the new science of expertise

Anders Ericsson and Robert Pool



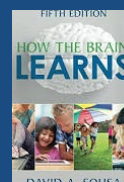
Optimising Learning: Implications of learning science research

R. Keith Sawyer



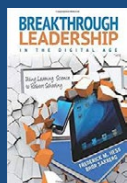
The Brain-Targeted Teaching Model for 21st Century Schools

Mariale M. Hardiman



How the Brain Learns

David A. Sousa



Breakthrough Leadership in the Digital Age

Frederick M. Hess and Bror V. H. Saxberg



Building Blocks for Learning

Brooke Stafford-Brizard



The Evidence Base for How We Learn

Stephanie M. Jones and Jennifer Kahn



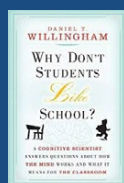
The Science of Summit

Summit Public Schools



Foundations for Young Adult Success

Jenny Nagaoka, Camille A. Farrington, Stacy B. Ehrlich, and Ryan D. Heath



Why Don't Students Like School?

Daniel T. Willingham

Apply What You've Learned

In addition to spurring additional exploration and learning, we also aspire for this primer to prompt all of us to apply what we've learned to our own work. Of course, designing for all these principles requires us to think about many interrelated pieces that come together to create the whole. For example, if we aspire to integrate high-quality practice into a learning environment, it means everything from the curriculum to the schedule to the knowledge, skills, and mindsets held by adults will need to align in support of this aspiration.

At Transcend, we use the framework below to help us think about the various “system elements” that must be designed and built in alignment with a community’s vision for learning. As you consider how each principle can be applied to your school design, it may be helpful to do so through the lens of these system elements.



System Elements



Curriculum, Instruction & Assessment

The content young people learn and how they learn it, as well as how they demonstrate their learning and progress toward new goals.



School Community & Culture

The makeup, rituals, and community practices of the entire learning environment.



Adult Roles, Hiring & Development

The roles adults play; the knowledge, skill, mindset, and experience profiles those roles demand; and resources that support how adults communicate, interact, and develop.



Scheduling & Use of Time

How learners and adults move through time—when they arrive and leave, how long they spend engaged in different experiences, and how this varies by individual.



Family & Community Partnerships

How learners and staff interact with families and the broader world outside the immediate learning community.



Space & Facilities

The design and organization of the physical space where learning occurs.



Technology & Tech Infrastructure

The hardware, software, and connective infrastructure used to support communication and learning.



Communications

How the work of the school is shared externally with families, the local community, and the larger field of education in order to ensure understanding and garner support.



Budget & Operations

How budgets are allocated, as well as operational dimensions such as transportation, nutrition, and meal systems.



Continuous Learning & Improvement

How everyone in the learning community understands success and progress, learns and reflects together, and influences the evolving model.

As mentioned in the introduction, our *Designing for Learning Cards* can help you further understand and apply the information in this primer. Each card focuses on one of the 16 principles and includes “How might we” questions to spur thinking about how best to honor the principle. Each deck also includes a variety of activities. You can [download a free printable version](#) or [buy the deck pictured below](#). You can also hover your phone’s camera over the QR code to the right to access these links and resources.



What’s Next for Transcend

At Transcend, we will continue to explore the research on how learning happens with the goal of making this knowledge increasingly accessible and usable for design teams everywhere. This will inevitably involve continuing to update this primer based on new research and what we learn from using it with our school partners. Over time, we will take on a few concrete projects in order to further expand the knowledge base, which are briefly described below.

- **Elaborating on Implications for Design**—We’ll work to further understand the many design decisions that could support the research on how learning happens.
- **Illustrating the Principles in Action**—We’ll engage in a focused search for school designs that embody the ideas in this primer.

We recognize that many other individuals and organizations are also tackling similar challenges. If you are interested in collaborating with us as we embark on this journey, please email cynthia@transcendeducation.org.



Appendix

Cognition Principles &
Implications

Motivation Principles &
Implications

Identity Principles &
Implications

Individual Variability
Principles & Implications

Works Cited



Cognition Principles & Implications

Focused Attention

People learn best when they direct their focus toward the content and experiences most relevant to learning.

To support Focused Attention, learning environments should:

- Help learners feel physically and psychologically safe and healthy
- Ensure that learning objectives and activities are clear
- Minimize sensory distractions
- Provide consistency

Manageable Cognitive Load

People learn best when they are challenged but are processing a manageable amount in their working memory.

To support Manageable Cognitive Load, learning environments should:

- Minimize cognitive and emotional distractions
- Break learning into manageable, logically sequenced increments
- Represent content and experiences clearly
- Respond to individual learner readiness with tailored supports and pacing
- Ensure that individual learners achieve competency with prerequisite objectives before they move on

Meaningful Encoding

People learn best when new learning is experienced in memorable ways and is related to prior knowledge.

To support Meaningful Encoding, learning environments should:

- Promote distinctive or emotionally compelling learning experiences
- Connect new learning to learners' prior knowledge and experiences
- Help learners make underlying factual and conceptual connections
- Integrate multiple representations of content through different modalities, problem types, and contexts

Effective Practice

People learn best when they practice challenging-but-doable skills at frequent, focused intervals and across diverse contexts.

High-Quality Feedback

People learn best when they receive timely and targeted feedback to guide their improvement.

Metacognitive Thinking

People learn best when they are able to plan, observe, evaluate, and adjust their own learning processes.

To support Effective Practice, learning environments should:

- Use each learner's current proficiency to plan opportunities for practice
- Provide learners with ongoing opportunities to engage in focused, frequent practice, across diverse contexts
- Build learners' own understanding of effective practice

To support High-Quality Feedback, learning environments should:

- Build learners' understanding of what success looks like
- Offer sufficient, timely opportunities for giving and receiving feedback so that learners can improve
- Ensure feedback provides a sufficient and accurate analysis of a learner's progress as well as guidance for improvement

To support Metacognitive Thinking, learning environments should:

- Make the skills and mindsets that support metacognitive thinking explicit learning objectives
- Help learners understand how different beliefs and messages may be impacting their thinking
- Ensure opportunities for learners to apply metacognitive thinking strategies across all learning contexts
- Develop a culture in which thinking about one's thinking is the norm



Motivation Principles & Implications

Value

People learn best when they find the content, outcomes, process, and/or relationships associated with learning to be important and relevant.

To support Value, learning environments should:

- Ensure that what is being learned feels relevant to the interests and goals of all learners
- Ensure how learning occurs feels compelling to learners
- Enable learners to work with peers and adults with whom they have meaningful relationships
- Use extrinsic rewards only sparingly and support progress toward intrinsically motivating goals

Self-Efficacy

People learn best when they believe in their ability to grow and achieve mastery of what they are learning.

To support Self-Efficacy, learning environments should:

- Engage learners in tasks that are challenging but doable
- Help learners set goals, plan toward them, and reflect on their progress
- Frame failure as a temporary state that can be changed by changing one's behavior
- Ensure that learners have trusted adults from whom they can seek help when they feel insecure about their abilities

Sense of Control

People learn best when they perceive that they have meaningful and appropriate agency over their learning.

To support Sense of Control, learning environments should:

- Provide appropriate autonomy over when, where, or how learning is pursued
- Help learners attain the supports and resources needed to achieve their goals
- Minimize external barriers to learning

Constructive Emotions

People learn best when they are in constructive emotional states versus ones of excessive stress or anxiety.

To support Constructive Emotions, learning environments should:

- Be warm and joyful spaces
- Foster positive relationships between peers, as well as between adults and learners
- Support physical and psychological health and well-being
- Help learners diffuse negative emotional states



Identity Principles & Implications

Self-Understanding

People learn best when they have a deep understanding of who they are and can use this knowledge to maximize their learning.

To support Self-Understanding, learning environments should:

- Deepen learners' understanding of their life story, heritage, and community
- Help learners identify and reflect on their strengths and areas for growth
- Immerse learners in new contexts and activities
- Offer opportunities for learners to express their various changing identities
- Help learners reflect on their current identities, desired future identities, and how best to bridge the two

Sense of Belonging

People learn best when they feel connected to, as well as accepted by, the people and environment around them.

To support Belonging, learning environments should:

- Be relevant to and celebrate learner's identities
- Provide all learners with opportunities to be heard and encourage participation
- Hold high expectations for all learners
- Help learners understand that self-doubt happens to everyone
- Minimize zero-tolerance and utilize restorative practices to re-establish trust and connectedness

Navigating Identity Threats

People learn best when negative beliefs associated with their identity are minimized or buffered against.

To support Navigating Identity Threats, learning environments should:

- Cue learners' motivating identities over identities that may trigger stereotypes or self-doubt
- Minimize actions, words, or images that may trigger negative self-perceptions
- Expose learners to individuals who have countered identity threats
- Help learners understand and act against systemic inequity and personal experiences of bias



Individual Variability Principles & Implications

Life Experiences

People learn best when their unique life advantages and adversities are understood and responded to.

To support Life Experiences, learning environments should:

- Understand the privileges and adversities that each learner carries
- Ensure that each learner is supported by a caring adult
- Use trauma-informed practices
- Provide or connect learners and families with non-academic resources and supports
- Leverage assets in learners' home and community contexts to support learning

Developmental States

People learn best when their experiences align with where they are developmentally.

To support Developmental States, learning environments should:

- Support key developmental tasks that occur across different phases of life
- Respond flexibly to reach all learners at their own developmental zones physically, cognitively, socially, and emotionally
- Support learners in understanding and responding to their own development

Learning Differences

People learn best when their unique learning needs are identified, and resources and supports are aligned with these needs.

To support Learning Differences, learning environments should:

- Ensure individual learners' needs and strengths are understood by adults and learners themselves
- Respond to differences by enabling learners to take in, engage with, and demonstrate learning in different ways
- Provide tailored scaffolds and supports in response to specific needs
- Maintain high standards for all learners, no matter their needs

Works Cited

Ambrose, S.A., Bridges, M.W., DiPietro, M., Lovett, M.C., & Norman, M.K. (2010). *How learning works: Seven research-based principles for smart teaching*. San Francisco, CA: Jossey-Bass.

Bandura, A. (1982). Self-efficacy mechanism in human agency. *American Psychologist*, 37(2), 122–147. <http://dx.doi.org/10.1037/0003-066X.37.2.122>

Boser, U. (2017). *Learn better: Mastering the skills for success in life, business, and school, or how to become an etxpert in just about anything*. New York, NY: Rodale.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (2000). *How people learn: Brain, mind, experience, and school*. Washington, DC: National Academy Press.

Cantor, P., Little, B., Darling-Hammond, Linda., Edley, C., Osher, D., & Rose, T. (2017). *Pre-reading materials: Science of learning and development convening*. Unpublished manuscript.

CAST. (n.d.). *About Universal Design for Learning*. Retrieved from <http://www.cast.org/our-work/about-udl.html#.W89tii-ZPJw>

Center on the Developing Child. (2012). *In brief: Executive function*. <https://developingchild.harvard.edu/resources/inbrief-executive-function/>

Center on the Developing Child. (2010). *The foundations of lifelong health are built in early childhood*. Retrieved from <https://46y5eh11fhgw3ve3ytpwxt9r-wpengine.netdna-ssl.com/wp-content/uploads/2010/05/Foundations-of-Lifelong-Health.pdf>

Center on the Developing Child. (2007). *The science of early childhood development*. Retrieved from <https://46y5eh11fhgw3ve3ytpwxt9r-wpengine.netdna-ssl.com/wp-content/uploads/2007/03/InBrief-The-Science-of-Early-Childhood-Development2.pdf>

Center on the Developing Child. (n.d). *Toxic stress*. Retrieved from <https://developingchild.harvard.edu/science/key-concepts/toxic-stress/>

Clark, R.C. & Mayer, R.E (2011). *e-Learning and the Science of Instruction: Proven Guidelines for Consumers and Designers of Multimedia Learning*. Pfeiffer; 3rd edition.

Clark, R.E. & Saxberg, B. (2018). Engineering motivation using the belief-control-expectancy (BCE) framework. *Interdisciplinary Education and Psychology*, 2(1), 4. <https://doi.org/10.31532/InterdiscipEducPsychol.2.1.004>

Cleary, T.J. and Zimmerman, B.J. (2004). Self-regulation empowerment program: A school-based program to enhance self-regulated and self-motivated cycles of student learning. *Psychol. Schs.*, 41: 537–550. <http://dx.doi.org/10.1002/pits.10177>

Damon, W. (2008). *The Path to Purpose: Helping our children find their calling in life*. New York, NY: Free Press.

Davidson, R. J., & Kaszniak, A. W. (2015). Conceptual and methodological issues in research on mindfulness and meditation. *American Psychologist*, 70(7), 581-592. <http://dx.doi.org/http://dx.doi.org/10.1037/a0039512>

Davies, D. (2010). *Child development: A practitioner's guide* (3rd ed). New York, NY: The Guilford Press.

Deans for Impact (2015). *The science of learning*. Austin, TX: Deans for Impact. Retrieved from <https://deansforimpact.org/resources/the-science-of-learning/>

Deans for Impact (2016). *Practice with purpose: The emerging science of teacher expertise*. Austin, TX: Deans for Impact. Retrieved from https://deansforimpact.org/wp-content/uploads/2016/12/Practice-with-Purpose_FOR-PRINT_113016.pdf

Demetriou, A. (2000). Organization and development of self-understanding and self-regulation: Toward a general theory. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), *Handbook of Self-Regulation* (pp. 209-251). San Diego, CA, US: Academic Press. <http://dx.doi.org/10.1016/B978-012109890-2/50036-6>

DiAngelo, R. (2011). White fragility. *The International Journal of Critical Pedagogy*, 3(2), 54-70. Retrieved from <http://libjournal.uncg.edu/ijcp/article/view/249/116>

Driscoll, M. (2001). *Psychology of learning for assessment* (2nd ed). Boston: Allyn and Bacon.

Dweck, C. S. (2006). *Mindset: The new psychology of success*. New York, NY, US: Random House.

Ericsson, K. A. (2006). The influence of experience and deliberate practice on the development of superior expert performance. In K. A. Ericsson, N. Charness, P. J. Feltovich, & R. R. Hoffman (Eds.), *The Cambridge handbook of expertise and expert performance* (pp. 683-703). New York, NY, US: Cambridge University Press. <http://dx.doi.org/10.1017/CBO9780511816796.038>

Ericsson, K. A., Krampe, R. T., & Tesch-Römer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review*, 100(3), 363-406. <http://dx.doi.org/10.1037/0033-295X.100.3.363>

Ericsson, K. A. & Pool, R. (2016). *Peak*. Boston, MA: Houghton Mifflin Harcourt.

Erikson EH. (1972). *Childhood and society*. Harmondsworth, Middlesex: Penguin Books.

Festinger L (1954). A theory of social comparison processes. *Human relations*, 7(2): 117–140. <https://doi.org/10.1177/001872675400700202>

- Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of Educational Research*, 77(1), 81–112. <https://doi.org/10.3102/003465430298487>
- Hess, F.M. & Saxberg, B. (2014). *Breakthrough leadership in the digital age: Using learning science to reboot schooling*. Thousand Oaks, CA: Corwin.
- Headden, S and McKay, S (2015) *Motivation Matters: How new research can help teachers boost student engagement*. Retrieved from The Carnegie Foundation for Advancement of Teaching website: https://www.carnegiefoundation.org/wp-content/uploads/2015/07/Motivation_Matters_July_2015.pdf
- Hulleman, C. & Godes, O. & L. Hendricks, B. & Harackiewicz, J. (2010). Enhancing interest and performance with a utility value intervention. *Journal of Educational Psychology*, 102(4), 880-895. <https://doi.org/10.1037/a0019506>
- Hunt, R. (2003). Two contributions of distinctive processing to accurate memory. *Journal of Memory and Language*, 48(4), 811-825. [https://doi.org/10.1016/S0749-596X\(03\)00018-4](https://doi.org/10.1016/S0749-596X(03)00018-4)
- Katsuki, F. & Constantinidis, C. (2013). Bottom-up and top-down attention: Different processes and overlapping neural systems. *The Neuroscientist*, 20(5), <https://doi.org/10.1177/1073858413514136>
- Kimmel, S. (2016). Toward a sociology of the superordinate. In Michael S. Kimmel & Abby L. Ferber (Eds.), *Privilege: A reader* (pp. 12-25) Boulder, CO: Westview Press.
- Kirschner, P. A., & Van Merriënboer, J. J. G. (2008). Ten steps to complex learning: A new approach to instruction and instructional design. In T. L. Good (Ed.), *21st century education: A reference handbook* (pp. 244-253). Thousand Oaks, CA: Sage.
- Klein, S. B. & Loftus, J. (1988). The nature of self-referent encoding: The contributions of elaborative and organizational processes. *Journal of Personality and Social Psychology*, 55(1), 5-11. <http://dx.doi.org/10.1037/0022-3514.55.1.5>
- Klimstra, T. A., Hale, W. W., Raaijmakers, Q. A., Branje, S. J., & Meeus, W. H. (2009). Identity formation in adolescence: change or stability? *Journal of youth and adolescence*, 39(2), 150-62. <http://dx.doi.org/10.1007/s10964-009-9401-4>
- Koriat, A. (1993). How do we know that we know? The accessibility model of the feeling of knowing. *Psychological Review*, 100(4), 609-639. <http://dx.doi.org/10.1037/0033-295X.100.4.609>
- Kroger, J. (2017). Identity development in adolescence and adulthood. *Oxford Research Encyclopedia of Psychology*. <http://dx.doi.org/10.1093/acrefore/9780190236557.013.54>
- Liu, Z., Grady, C., & Moscovitch, M. (2016). Effects of prior-knowledge on brain activation and connectivity during associative memory encoding. *Cerebral Cortex*, 27(3), 1991-2009. <https://doi.org/10.1093/cercor/bhw047>
- Mallet, C.S. (2015). The school-to-prison pipeline: A critical review of the punitive paradigm shift. *Child and Adolescent Social Work Journal*, 33(1), 15-24. <https://doi.org/10.1007/s10560-015-0397-1>

- Marcia, J. E. (1966). Development and validation of ego identity status. *Journal of Personality and Social Psychology*, 3(5), 551-558. <http://dx.doi.org/10.1037/h0023281>
- McAdams, D. P. (2001). The psychology of life stories. *Review of General Psychology*, 5(2), 100-122. <http://dx.doi.org/10.1037/1089-2680.5.2.100>
- Meeus, W., Iedema, J., Helsen, M., & Vollebergh, W. (1999). Patterns of adolescent identity development: Review of literature and longitudinal analysis. *Developmental Review*, 19(4): 419-461. <https://doi.org/10.1006/drev.1999.0483>
- Melton, A. W. (1963). Implications of short-term memory for a general theory of memory. *Journal of Verbal Learning and Verbal Behavior*, 2(1), 1–21. [https://doi.org/10.1016/S0022-5371\(63\)80063-8](https://doi.org/10.1016/S0022-5371(63)80063-8)
- Murray, C. & Malmgren, K. (2005). Implementing a teacher–student relationship program in a high-poverty urban school: Effects on social, emotional, and academic adjustment and lessons learned. *Journal of School Psychology*, 43(2), 137-152. <https://doi.org/10.1016/j.jsp.2005.01.003>
- Nagaoka, J., Farrington, C.A., Ehrlich, S.B. & Heath, R.D. (2005). Foundations for young adult success: A developmental framework. Retrieved from <https://consortium.uchicago.edu/sites/default/files/publications/Foundations%20for%20Young%20Adult-Jun2015-Consortium.pdf>
- OECD. (2017). PISA 2015 results (volume III): Students' well-being, Paris: PISA, OECD Publishing. Retrieved from <http://dx.doi.org/10.1787/9789264273856-en>
- Ormrod, J.E. (2014). *How Motivation Affects Learning and Behavior*. Pearson Allyn Bacon Prentice Hall. Retrieved from <https://www.scribd.com/document/283325267/How-Motivation-Affects-Learning-and-Behavior-Article>.
- Osher, D., Cantor, P., Berg, J., Steyer, L., & Rose, T. (2018). Drivers of human development: How relationships and context shape learning and development. *Applied Developmental Science*, 1-31. <https://doi.org/10.1080/10888691.2017.1398650>
- Oyserman, D. & Mesmin, D. (2010). Identity-based motivation: Implications for intervention. *The Counseling Psychologist*. 38(7), 1001-1043. <https://doi.org/10.1177/0011000010374775>
- Pane, J.F., Steiner, E.D., Baird, M.D., and Hamilton, L.S. (2015). Continued progress: Promising evidence on personalized learning. Santa Monica, CA: RAND Corporation. Retrieved from https://www.rand.org/pubs/research_reports/RR1365.html
- Pape, B. (n.d.). Learner variability is the rule not the exception. Retrieved from <https://digitalpromise.org/wp-content/uploads/2018/06/Learner-Variability-Is-The-Rule.pdf>
- Romero, C. (2015). What we know about belonging from scientific research. Mindset Scholars Network. Retrieved from <http://mindsetscholarsnetwork.org/wp-content/uploads/2015/09/What-We-Know-About-Belonging.pdf>
- Rose, T. (2016). *The end of average*. New York, NY: HarperCollins Publishers.

- Rutter, M. (2001). Psychosocial adversity: Risk, resilience, and recovery. In Jack M. Richman, Mark W. Fraser Westport (Eds.) *The context of youth violence: Resilience, risk, and protection*. Westport (pp.13-42). Westport, CT: Praegers Publishers.
- Ryan, R.M. & Deci, E.L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary educational psychology*, 25(1), 54-67. <https://doi.org/10.1006/ceps.1999.1020>
- Schmidt, H.G. (1983). Problem-based learning: Rationale and description. *Medical Education*, 17(1), 11-16. <https://doi.org/10.1111/j.1365-2923.1983.tb01086.x>
- Silber, S. (2015). *NeuroTribes: The legacy of autism and the future of neurodiversity*. New York, NY: Penguin Random House.
- Sousa, David A. (2016). *How the brain learns*. London: SAGE Publications.
- Steele, C.M., Spencer, S.J., & Aronson, J. (2002). Contending with group image: The psychology of stereotype and social identity threat. *Advances in Experimental Social Psychology*. 34: 379-440. [http://dx.doi.org/10.1016/S0065-2601\(02\)80009-0](http://dx.doi.org/10.1016/S0065-2601(02)80009-0)
- Steinberg, L., & Morris, A.S. (2001). Adolescent development. *Annual Review of Psychology*, 52, 83-110.
- Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science*, 12 (2), 257-285. https://doi.org/10.1207/s15516709cog1202_4
- Sweller, J. (2011). Cognitive load theory. *Psychology of Learning and Motivation*, 55, 37-76. <https://doi.org/10.1016/B978-0-12-387691-1.00002-8>
- Tabbers, H.K., Martens, R.L., & van Merriënboer, J.J.G. (2004). Multimedia instructions and cognitive load theory: Effects of modality and cueing. *British Journal of Educational Psychology*, 74(1), 71-81. <http://dx.doi.org/10.1348/000709904322848824>
- Tanner, K.D. (2012). Promoting student metacognition. *CBE—Life Sciences Education*, 11, 113-120. <https://doi.org/10.1187/cbe.12-03-0033>
- Tatum, B. D. (1992). Talking about race, learning about racism: The application of racial identity development theory in the classroom. *Harvard Educational Review*, 62(1), 1-24. <http://dx.doi.org/10.17763/haer.62.1.146k5v980r703023>
- Tobias, S. (1994). Interest, prior knowledge, and learning. *Review of Educational Research*, 64(1), 37-45. <https://doi.org/10.3102/00346543064001037>
- Tindall-Ford, S., Chandler, P., & Sweller, J. (1997). When two sensory modes are better than one. *Journal of Experimental Psychology: Applied*, 3, 257-287. <http://dx.doi.org/10.1037/1076-898X.3.4.257>
- Tomlinson, C. A., & Strickland, C. A. (2005). *Differentiation in practice grades 9-12: A resource guide for differentiating curriculum*. Alexandria, VA: Assoc. for Supervision and Curriculum Development.

CAST. (2008). About universal design for learning. Retrieved from: cast.org/our-work/about-udl.html#.XZkMsudKhBx

Valenzuela, A. (1999). *Subtractive schooling: U.S.- Mexican youth and the politics of caring*. Albany, NY: State University of New York Press.

Vygotsky, L. (1978). Interaction between learning and development. In Gauvin & Cole (Eds.) *Reading on the development of children*. New York, NY: Scientific American Books.

Wade, R., Jr., Shea, J. A., Rubin, D., & Wood, J. (2014). Adverse childhood experiences of low-income urban youth. *Pediatrics*, 134(1). <https://doi.org/10.1542/peds.2013-2475>

Walton, G. M. & Cohen, G.L. (2011). A brief social belonging intervention improves academic and healthy outcomes of minority students. *Science*, 331(6023), 1447-1451. <https://doi.org/10.1126/science.1198364>

Walton, G.M. & Cohen, G.L (2007). A question of belonging: Race, social fit, and achievement. *Journal of Personality and Social Psychology*, 92(1), 82-96. <https://doi.org/10.1037/0022-3514.92.1.82>

Wigfield, A., & Wagner, A. L. (2005). Competence, motivation, and identity development during adolescence. In A. J. Elliot & C. S. Dweck (Eds.), *Handbook of competence and motivation* (pp. 222-239). New York, NY, US: Guilford Publications.

Willingham, D.T. (2004). Practice makes perfect—but only if you practice beyond the point of perfection. *American Educator*. Retrieved from <https://www.aft.org/periodical/american-educator/spring-2004/ask-cognitive-scientist>

Willingham, D.T. (2005). How praise can motivate—or stifle. *American Educator*. Retrieved from <https://www.aft.org/ae/winter2005-2006/willingham>

Willingham, D.T. (2008). What is developmentally appropriate practice? *American Educator*. Retrieved from https://www.aft.org/sites/default/files/periodicals/willingham_1.pdf

Willis, J. (2007). The neuroscience of joyful education: Brain research tells us that when fun stops, learning often does too. *Educational Leadership*. Retrieved from <http://www.ascd.org/publications/educational-leadership>

Yeager, D.S., Lee, H.Y. & Dahl, R.E. (2017). Competence, motivation, and identity development during adolescence. In A. J. Elliot, C. S. Dweck & D.S. Yeager (Eds.), *Handbook of competence and motivation* (pp. 222-239). New York, NY, US: Guilford Publications

Zimmerman, B. J. (2001). Theories of self-regulated learning and academic achievement: An overview and analysis. In B. J. Zimmerman & D. H. Schunk (Eds.), *Self-regulated learning and academic achievement: Theoretical perspectives* (pp. 1-37). Mahwah, NJ, US: Lawrence Erlbaum Associates Publishers.