Clark N. Quinn

Learning Science

for Instructional Designers

From Cognition to Application

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To all the researchers who advance our understanding of learning, and the designers who apply that research to create effective and engaging learning experiences.

Contents

Preface ... vii
Acknowledgments ... ix

Chapter 1. Introduction to Learning Science ... 1
Chapter 2. From Neural to Useful ... 11
Chapter 3. Architectural Artifacts ... 31
Chapter 4. Emergent Cognition ... 49
Chapter 5. Let’s Get Emotional ... 61
Chapter 6. Going Meta ... 77
Chapter 7. Implications ... 87
Chapter 8. Putting It All Together ... 97

Appendix: Collected Learnings ... 113
References ... 119
Recommended Resources ... 123
Index ... 127
About the Author ... 133

Preface

If we're truly being professionals about designing learning, there's a clear onus to be aware of what learning science tells us. And that runs from the cognitive story at the core through to the learning prescriptions that emerge. Quite simply, we have a responsibility.

If a doctor pursues approaches unjustified by science, they're liable for malpractice. Similarly, we should be implementing scrutable practices. There are consequences for not doing so. If we use approaches that aren't justified, we can squander resources, but more importantly, we can undermine our own goals. In the worst case, lives are lost. In fact, you'll see that industries with significant potential downsides of getting it wrong practice in ways not typically seen in corporate America. Look at the military and airlines as two examples.

So, we have a responsibility to our learners, our organizations, and ourselves to understand and apply what's known, whether from a deep-seated curiosity and caring, or just because it's what's required of us.

I come from the former category. I was kind of at loose ends, degree-wise. I was tutoring (physics, calculus, chemistry) on campus for some extra income, and taking some computer science courses. I ended up doing computer support for the office that coordinated the tutoring. And a light went on: computers supporting learning! My university didn't have an appropriate degree program (back then, many didn't; I was carrying around decks of punch cards in order to run the computer programs), but it *did* have a way to design your own. So, that's what I did, and learning design and technology has been my career ever since.

I've programmed educational computer games; gone back for a PhD in what was, effectively, applied cognitive science; and gone the academic route: a post-doctoral and then a faculty position. For complicated reasons, I also joined some government-sponsored initiatives in online learning before joining a startup in educational technology. When that went four paws to the moon in the economic chaos that characterized the collapse of the internet bubble, I ended up as a consultant (which went from being a euphemism for unemployed to a way of life).

However, my career has always been about exploring ways to use technology that allow us to pursue our goals more effectively and efficiently.

Along the way, I've maintained a passionate interest at the intersection of four related fields. I've looked at learning—behavioral, cognitive, post-cognitive, social, educational, even *machine* learning—to see what's known. Similarly, I've followed what's known about engagement, including motivation, anxiety, curiosity, drama, and humor, to understand how we create experiences that are meaningful, even transformative. I've also followed technology trends from before personal computers, including artificial intelligence, mobile, content systems, constructed realities (augmented and virtual), and more, to find out what new capabilities we might use. Finally, I've looked at design, including interaction, industrial, graphic, software engineering, and of course instructional approaches, to ensure that we're applying this knowledge in the most useful ways.

That's my mission: Discover how to create experiences that tap into our hearts and apply our minds to achieve useful ends. It's all about strategic learning experience design (LXD). (And through technology, since I'm admittedly a sucker for the latest toy.) Which means I have looked at practical ways to integrate this suite of knowledge. Here, I'm focusing on learning, and its application to instruction.

And, as you'll see, our brains consolidate information. We don't remember many exact details; instead, we remember a synthesis. And that's what I'm doing here. This is not a detailed academic treatise, but rather an attempt to digest and communicate a practical interpretation of what's known about cognition and learning to provide a basis for better design.

I hope you find it comprehensible and useful.

Acknowledgments

There are so many people I owe gratitude to, and I've tried to catalog them in previous books. A few who continue to support me include the following.

Jim "Sky" Schuyler has been a mentor, colleague, and friend since out of college and continuing on. A great role model.

Marcia Conner has been a mentor at stages in my career, providing opportunities and helping me learn important lessons.

My Internet Time Alliance colleagues, instigated by the late, great Jay Cross—Jane Hart, Harold Jarche, and Charles Jennings—all have served to improve my understanding of learning and life.

My IBSTPI colleagues, including Mark Lee, Kathy Jackson, Davida Sharpe, Fernando Senior, Saul Carliner, Florence Martin, and Stella Porto, have been sources of inspiration and learning.

Thanks also to all my colleagues in many different forums; in particular (and in no particular order), Will Thalheimer, Karl Kapp, Patti Shank, Julie Dirksen, Mirjam Neelen, Donald Clark, Jane Bozarth, Jen Murphy, Chad Udell, Connie Malamed, Matthew Richter, Guy Wallace, and the other mythbusters and science interpreters have all helped shape my rigor and understanding. Apologies if I haven't mentioned you! And I'm grateful to so many more colleagues who inspire me and support us all in doing better.

I'm grateful to all the organizations that have given me platforms to share my thinking on how to improve the field, through workshops, keynotes, talks, articles, books, and courses. Thanks to societies, publishers, private organizations, individuals, and more.

Also, thanks to the organizations that have brought me in to work with them. It's a deep pleasure to be able to get hands-on with real problems and try to "Quinnovate" some new ideas. I've learned so much from these opportunities with public and private companies, not-for-profits, governmental bodies, educational institutions, and more.

I'm also grateful to Justin Brusino, Alexandria Clapp, Jack Harlow, Melissa Jones, Caroline Coppel, Hannah Sternberg, Shirley Raybuck, Rose Richey, Stephanie Shaw, and the rest of the ATD team who've pushed and supported me through this experience. This book exists because of Justin and Alexandria is immeasurably better because of Alexandria, Jack, Hannah, and Caroline, and looks great thanks to Melissa, Shirley, Rose, and Stephanie.

My family—Erin (who served as a reviewer of an early draft), Declan, and most of all, LeAnn—have been stalwart supporters. With love and gratitude.

CHAPTER 1

Introduction to Learning Science

- What is learning science?
- Why we need learning science
- How learning science is conducted
- How to find learning science resources

> **plunger** (plŭn′jər)
> The plunger in the pump was broken. A *plunger* is a:
> (a) dolphin
> (b) pump part
> (c) brown car
> —A found example of online learning

What possible learning purpose does this example serve? The question comes right after the content. It asks a question where the answer is implied by the immediately preceding material, and the alternatives are nonsensical or silly.

This example is emblematic of why we need learning science. Because when we design learning experiences, we want to achieve an outcome. And, if we don't do it according to learning science, we could waste our stakeholders' resources and our learners' time.

To address the need in this book, we'll go through basic cognitive architecture, and then the learning phenomena (cognitive artifacts like mental models) of reasoning that arise from this architecture. We'll look beyond cognitive to emotional aspects, and we'll point out the implications for learning experiences and the design of specific elements.

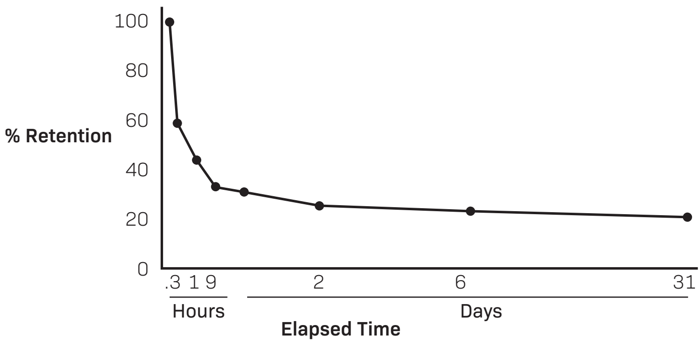
First, however, we should establish more about the science we're investigating.

What *Is* This Learning Science?

Learning science is, not surprisingly, the scientific study of learning. It means looking at how learning works, and also what facilitates and hinders learning. It provides a strong basis for designing instruction. It is relatively new, however.

Our brains are the core organs of learning. We perceive the world, act, observe the outcomes, and reflect. Consequently, studying learning comes from studying the mind. The ancient Greeks philosophized about how our brains work, but scientific exploration of learning really only began with Hermann Ebbinghaus's studies of memory in the 1800s (Figure 1-1).

Figure 1-1. Ebbinghaus's Memory Study



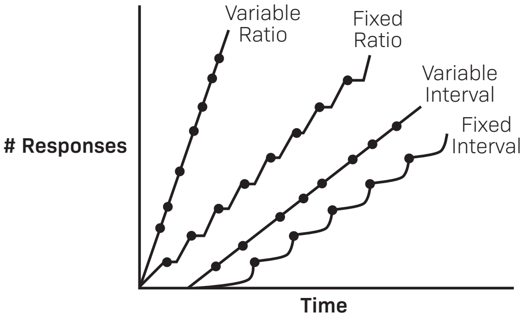
The field of psychology has subsequently gone through several movements, including behaviorist, cognitive, and constructivist. Each of these added insights have furthered our understanding.

The behaviorist school started out by saying that we can't talk about what's going on inside the brain; we only can connect inputs with outputs. This was the era of Pavlovian conditioning and stimulus-response approaches. Robust findings include the value of different reinforcement schedules (think gambling; Figure 1-2) and the Yerkes-Dodson performance-arousal curve.

The cognitive revolution said that we can hypothesize what brain structures must exist. Research showed various facets of our information processing that have stood the test of time. There was a vision that we were formal, logical reasoners.

Revelations that we're not the formal-thinking beings we thought prompted the move to a more *situated*, or constructivist, view of cognition. Here, we realize that our thoughts are an interaction between context and previous experience. We may use concepts differently depending on context, and certain types of reasoning are problematic.

Figure 1-2. Reinforcement Schedules



Importantly, psychology isn't the only field that talks about how our minds work. Insight still comes from fields such as philosophy, neuroscience, linguistics, anthropology, and sociology. The field of cognitive science was created to be an umbrella under which these differing elements could be integrated. And it's provided a solid foundation for developments including communication and collaboration practices, interface design, and artificial intelligence.

Learning science is similarly interdisciplinary. Research insights have come from psychological investigations, educational studies, ethnographic approaches, and sociological work. (A side effect is that results from one discipline may not take into account results from another, related discipline.) A growing awareness of this relatedness led to the establishment of the discipline in the 1990s.

Learning science is also global. I was a graduate student in the United States during the establishment of the discipline, and then a post-doctoral fellow. There is so much research done in the US, it was easy for me be focused nationally instead of internationally.

Later, I had the good fortune to take a faculty position in Australia, and quickly (and shamefacedly) learned my awareness of research was blinkered. I was also able to visit global conferences and get exposed not only to the field's interdisciplinary nature, but also to its global cohort of researchers. And it's important to realize, and recognize, that the results and implications properly span cultures and nationalities.

Why Should *We* Care?

Another plausible question is *why* learning science? Why should we understand the underlying cognitive mechanisms, the artifacts and limitations of our mental architecture, and the associated elements? Can't we just follow the resulting precepts of instructional design? I'll suggest that the answer is a resounding "no."

My short answer is that it's a professional imperative. Instructional design is applied learning science. How can we claim to be scrutable in our approaches if we don't track the underlying research, and can't articulate how our designs reflect what is known? Just as you expect your doctor and financial adviser to be applying the latest outcomes, so too should you feel such an obligation when designing learning experiences. We don't want to be guilty of design malpractice, after all.

The longer answer starts with the realization that instructional design is a dynamic field. Even David Merrill, one of the founders of and forces in instructional design (and a truly nice person to boot), has had phases of change. His Component Display Theory, for instance, progressed to ID2, and now he's on about a "pebble in a pond." New understandings in learning science drive the need to revise our approaches.

The foundations we build our design processes on have shifted. Instructional design emerged as an artifact of World War II, when behaviorism was in force. As we've gone through the cognitive era and into a post-cognitive constructivist awareness, our design bases similarly adapted. Each of those transitions has had implications for what we think learning is, and consequently what makes sense as pedagogy.

Recent understandings continue to drive our approaches. To be able to react to new approaches means grasping some fundamental underpinnings. Separating them from other explanations is a critical component of being a successful practitioner. (I once was presented with a "hydraulic" model of learning, an engineering metaphor misapplied to understanding our thinking!)

This implies a second reason to understand the basics: Folks will continue to propose new approaches. They will come to these approaches sometimes from pure conviction, rightly or wrongly, but also for commercial reasons. Practitioners need to be careful about evaluating new claims. With an understanding of the basic mechanisms, you're better prepared to avoid the learning myths that plague our field (as I documented in my last tome, *Millennials, Goldfish & Other Training Misconceptions*).

Also, instructional design has great recommendations, such as we see in the movement to evidence-based methods as discussed in recent books by Ruth Clark and by Mirjam Neelen and Paul Kirschner. Thus, a third reason is that there are still gaps that prescriptions won't fill. Making good choices in lieu of guidance depends on understanding the mechanisms as suggested by theories.

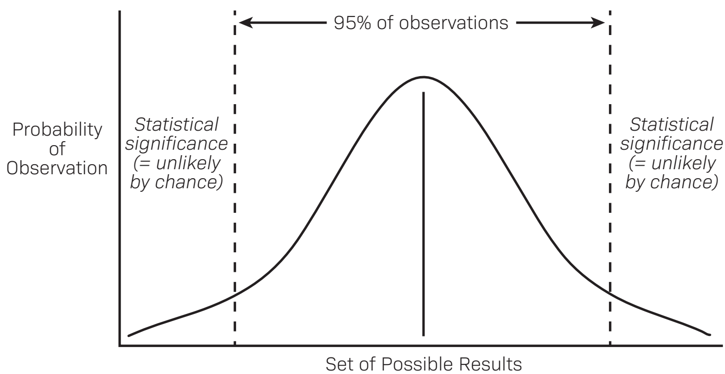
How Does One "Learning Science"?

Learning science is the result of the usual processes of science. While there are many different methods, the basis we should be using is the result of experimentally tested and statistically validated approaches.

A major distinction is between quantitative and qualitative studies. In quantitative studies, you have clear metrics that are objectively obtained, such as scores on tests or observationally clear performance while completing tasks. Here we typically have some subjects working in one way (such as under the experimental treatment), and a control group in another, typically pre-existing, way, and we then look at the outcomes.

Statistics are used to determine with some degree of certainty whether the outcome is due to chance (Figure 1-3). It is a probabilistic game, because even significant tests have a chance of being false 5 percent of the time. This is one of the reasons it is preferable if the results are replicated. Reputable reports, such as those in a peer-reviewed journal or book chapter, will detail the study sufficiently so that someone can conduct the same study. And this happens.

Figure 1-3. Statistical Significance



Note that despite their empirical nature, experiments tend to be driven by theory. While there are some purely experimental studies ("What will we find?"), most times someone creates a hypothesis, and then tests it. For instance, someone may say, "Hmm, one prediction of cognitive load theory might be that we need to integrate labels into diagrams to keep people from generating more mental overhead by looking back and forth between them, trying to integrate the element and its meaning." They run a test, and find out if it's true (spoiler: it is).

Qualitative studies similarly use the scientific method, but they take data that's more complex than just numbers (verbal protocols, interviews) and code it, and then look for patterns. Typically, you need some controls on the interpretation to support the resulting analysis, such as someone independently coding a subset of the data and looking for the agreement. For my PhD thesis, for instance, I coded transcripts of subjects' verbal efforts in problem solving. As a control, I also hired a student to code a subset of the data using my rubric, and checked to see that the coding was reliably consistent. Finding (and reporting) that the degree of agreement was sufficiently high meant that we could then report that the data was reliably coded.

Importantly, your data should get reported in a journal. What this means is that you write it up in unambiguous language and peers review it, and it must pass scrutiny. Along with the results, you situate your work in others', via a literature review, and you make clear what the unique contribution is. The peer scrutiny can be a problem, particularly if the work is upending established protocol. There's a whole field of science *about* science, and concepts like Thomas Kuhn's paradigm shift are used to characterize the bigger changes. Yet overall the process works.

Be aware that the language used for journals is an obscure dialect known as academese. This is typically based on English, but uses an esoteric and almost deliberately impenetrable vocabulary. It takes training to be able to comprehend it. Learning to read academese is a valuable skill, but probably not for most folks.

At its core, however, the systematic process of experimentation and theory advancement, as well as theory revision and replacement, is all part of science. And its results are the best basis upon which to determine our approaches.

On the Lookout for Learning Science

As suggested, the best way to track science is to read journals. And, again, not everyone should be expected to read them. The nuances of appropriate methodologies are subtle, and not necessarily of use to all. What to do instead?

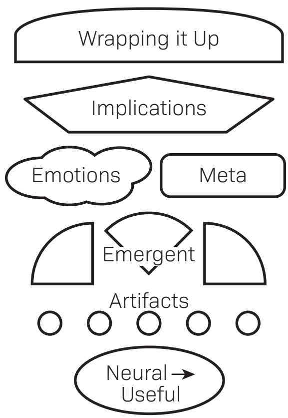
Fortunately, there is a cohort of folks who are reliable translators. In addition to the scientists—those who can reliably communicate to laypeople, and that's not all of them—are folks steeped in the traditions (typically with PhDs from experimental programs) but who work in the real world. A number of them continue to serve as valuable proponents for applications of the science.

These translators write blog posts, articles, chapters, and books. They present via webinars, conferences, and keynotes. You should know them, listen to them, and, of course, hire them. They can do workshops to educate your team, consult to improve your processes, and help you plan to better align. They're the source of the best principles to apply to your practices. I maintain a list of the best translators at quinnovation.com/translators.html. And you should know the places where translation writings aggregate. Not every place is rigorous about the quality of its materials.

The Rest of the Book

With that all said, what am I going to cover? I think it's important to work our way up from the fundamentals of the brain to what that means for learning. This means a steady progression through several areas (Figure 1-4).

Figure 1-4. Book Structure



First, we'll look at our cognitive architecture using a "stores and processes" model. Here we'll learn the basic information-processing cycle, from sensed signals to long-term memory.

The artifacts for learning that emerge from this architecture are next. Tied in to attention and working memory limitations is cognitive load. Similarly, specific elements around models have implications from refining retrieval to developing content.

We'll then review the phenomena that are outcomes of this architecture. We'll look at some more recent frameworks that document some characteristics of our thinking that are not logical, and what that means. This includes looking at processing media.

From there we'll go beyond the cognitive to the emotional—or, rather, affective and conative (who we are and our intent to learn). We'll explore what's known about experience, motivation, and more.

We'll also examine learning to learn. This important area is often neglected, yet it can have an impact on success. This includes a culture of learning.

Then we'll delve into the implications of all this science on the elements of learning design. We'll explore introductions and closings, concept models, examples, and, of course, practice.

And we'll look at the elements in another way, as sets of prescriptions for design. This includes two frameworks and a detailed example.

Overall, our journey is:

- Chapter 2: Our brains, from the neural level to the level of language
- Chapter 3: Learning artifacts that arise from our architecture
- Chapter 4: Some new perspectives with implications for learning
- Chapter 5: The emotional side of learning
- Chapter 6: Learning to learn
- Chapter 7: Learning experience design implications
- Chapter 8: How it all fits together

That's it—buckle up; it's going to be a wild ride!

Activities

How do you get the most out of this book?

- Reframe the content, whether mentally, into different terms, or physically, in terms of rewriting core ideas, mind-mapping the content, or sketch-noting it.

- Reflect on how the content explains things you've experienced in the past, including good and bad learning.
- As you work through the content, ask: What does this imply that I should do (differently)?
- Make it a habit to track learning science translations and translators.

APPENDIX

Collected Learnings

Chapter 2

Ensure that any information you want learners to perceive is detectable. Using appropriate channels for information and providing sufficient duration is important. For instance, give learners control over dynamic media so they can pause or restart it; otherwise, information could be lost.

Consider accessibility. There are potential limitations in your audience. First, design so that there are redundancies, such as augmenting color with pattern. Second, provide alternatives, such as text of any audio. Third, provide support for alternative mechanisms, such as screen readers.

We need to help learners focus. Remove distractions that can add to cognitive load. If the ability to perform with noise or stress is part of the context, get the processing down first, then add in the extraneous factors. Second, help learners direct their attention appropriately. Integrate labels into diagrams, and use pointers or spread out messages to introduce things one by one.

Don't overload working memory. Keep the amount of information being processed at a low level. This includes contextual and conceptual knowledge. We can overload the system easily.

Help learners chunk necessary information. Given that we can hold only so many bits of information, support the general building of those bits. Be very clear about what has to be in the head, and what can be in the world. And then determine explicitly what should be considered as a whole concept. We want to ensure that what's represented in short-term memory is useful based on the context.

We need to support encoding and retrieval. Have learners elaborate the information to explain things in their past that are related to the performance need. And provide retrieval practice in the same mode as they'll need to use it. For instance, elaborate coaching by thinking of previously observed or experienced coaching situations, and have them retrieve your coaching information to use to accomplish a coaching goal. Provide connections for learners, or support them in generating relationships between the knowledge to be learned and their preexisting knowledge.

Knowledge structures are fluid. Provide sufficient practice to ensure that an appropriate level of discrimination between concepts is present when needed.

Match the instruction to the learning. The learning outcome should dictate what's an appropriate form of practice, and the necessitated knowledge in support.

Make the assessment tasks mimic the real-world tasks. Even if it's via multiple choice, have the question mimic the decision one needs to make, not the knowledge one needs to make it. If that knowledge needs to be automated, do so, but then have learners apply that knowledge. Otherwise, question why it's needed.

Chapter 3

Feedback should be impersonal, clear, minimal, and delivered upon completion of the practice. It should not only provide the outcome, but also explain why the answer was wrong and what would be correct.

Present models of causal relationships that provide a basis for predictions and explanations. Use them in examples and in feedback on practice.

Use the misconceptions people have in your learning design. Make your alternatives to the right answer common ways that people get it wrong. And address each mistaken approach individually.

Choose an appropriate suite of concrete contexts, spread across examples and practice, to support the needed transfer, near or far.

Ensure that the task requirements, with all the elements, are within the learner's reach (if not their grasp). Test to ensure that the requirements don't exceed learner capability.

Support appropriate automatization. This is like the previous recommendation to support chunking, but here it's about taking those designed chunks and ensuring sufficient practice and feedback to support taking the use of the chunks from conscious to rote.

Retrieve in the way to be used. If people need to *use* information to make decisions, have them do that, not merely demonstrate that they know the information.

Space learning out over time. Massed practice in an event model isn't likely to lead to sufficient retention. Build spaced practice into your learning model, and into your design process.

If you can, mix up the practice and manage challenge level. Switch from this element to that, which helps make it less predictable. Try to make the challenge level appropriate for where the learner is.

Take a second pass at your writing to trim it!

In general, use the right media for the message. You can mix it up to maintain variety for novelty's sake, but don't undermine the essential message. And consider comic or graphic-novel formats.

Chapter 4

The situated nature of our cognition means we can be prone to insufficiently transferring knowledge from one context to another. So, in addition to sufficient practice to support retention, we also need to consider the contexts of practice. We want to ensure that our practice contexts span the space of applicability—that is, cover all the situations we want the learner to apply the knowledge in. The practice contexts don't have to cover every situation, but instead cover sufficient breadth so that we'll appropriately transfer to those situations we didn't see in practice.

Don't put in your head what can be in the world. Our brains are very bad at remembering large quantities of information, particularly if it's arbitrary, and similarly bad at complex calculations. Digital technology is the reverse. We should determine what can be in the world first, and then design learning to accommodate those resources.

Use social learning activities when appropriate. That includes showing modeled examples (including the instructor modeling the behavior), and using group work when conditions are right.

Social learning is both powerful and costly. We need to be clear about when and how to use it. In situations like formal education, where learners are expected to regularly convene, use that time for important collaborative work. Discussions and projects are two examples. In other situations, don't require group work unless the focus is on a task that has a high degree of ambiguity or that requires far transfer. Here the benefits of negotiating a shared understanding will empower the desired outcomes.

Surprise is an important part of learning. We need to have our expectations challenged to be open to learning, and then models are valuable supports for improving our predictions. Failure has to be expected and made safe.

Chapter 5

Design for the learning, not the learner. That is, align the elements of models and examples to the practice that's appropriate to the desired outcome. Our learning objectives should be the determinant of the pedagogical approach. That does include understanding the learner audience, and any unique characteristics, but as of yet it's not a basis to adapt learning.

We want to keep anxiety low (unless stress is a component of the learning experience, and then we want to introduce it appropriately). That means reducing the stakes of assessment, and developing competence and confidence to appropriate levels.

We want to build motivation before an experience begins. We will do it again at the beginning of the experience, and maintain it throughout. We want learners aware that this is of value to them. We can make it appealing aesthetically, but the real value is in the emotional pull.

Build confidence in the learner by showing them their progress, and ensuring that they are improving.

Manage the challenge level. Increase the challenge as the learner demonstrates competency. This ties in with confidence.

Explicitly consider the emotions of the learner through the experience. Consider addressing motivation, anxiety, and confidence at the various stages of the learning process.

Use humor appropriately. Use it lightly to establish a positive and shared learning environment, be culturally sensitive, and don't use it in the midst of a learning decision.

As an extension of the alignment of "flow" and the zone of proximal development, this set of synergistic elements goes beyond content and creating a learning experience. The take-home lesson is, of course, that learning can, and should, be "hard fun."

The environment in which learning happens matters. Factors in the environment can foster or hinder learning outcomes. Ensure that you've created the culture for learning as well as the practice and content.

Chapter 6

Don't leave meta-learning to chance. Build in specific references to skills. Consider actually assessing and developing them as part of your overall curriculum.

Don't assume effective learning skills on the part of your learners. Be explicit about what makes effective learning, and consider actively evaluating and developing these skills.

While you may not be able to change beliefs about learning, demonstrate a commitment that persistence and effort do make a difference.

Consider creating opportunities for learners to reflect on their learning, individually or collectively. When possible, create concrete evidence of their actions and progress. Also, make opportunities for them to express their own understanding.

Don't assume effective generic skills on the part of your learners. As with meta-learning skills, be explicit about what makes effective learning, and consider actively evaluating and developing these skills.

Chapter 8

Serious games are, perhaps, the ultimate learning experience. Putting people into the role of making contextualized decisions is an ideal practice for learning. We can approximate that fairly closely without having to build, or develop to, a full game engine.

Just as our pedagogy should focus on doing, not on knowing, so too should our curriculum. We should be building meaningful tasks from component tasks. These naturally embed concepts, whereas the reverse isn't the case.

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Index

Page numbers followed by *f* refer to figures.

A

abstract examples, 38
"academese," 6
action
  choice of, 73
  learning as, 98
active manipulation, 74, 102–103
activity-based curriculum, 106, 106*f*
affective label (cognitive science), 61
Agreeableness (A), 63*f*
Allen, Michael, 94
anchored cognition, 102
anxiety, 64–65
ARCS model, 67
attention, 20–21, 20*f*
  in ARCS model, 67
  and memory, 22
  in Workplace of the Future, 104–105
attitudes toward learning, 83–84
Authorware, 94
automation, 40–41

B

backward design, 54, 55f
balanced challenge, 73
Bandura, Albert, 57
behavioral psychology, 2
behaviorism, 4
Being There (Clark), 50
Beiter, Carl, 97
Big Five personality traits, 62, 83–84
Bjork, Robert, 43
Blazing Saddles (film), 73
body feedback, 17
Bovair, Susan, 33
brain, 2, 11–13, 14*f*, 23, 27, 33, 53
Brandon, Robert, 55
Bransford, John, 102
Brazil, 97
Brooks, Mel, 73
Brown, Ann, 97
Brown, John Seely, 92, 97
Budge, Bill, 74
Burns, Ken, 47

C

Campbell, Joseph, 74
challenge, 68–69, 73, 96, 101
channels, 19
The Checklist Manifesto (Gawande), 51
choice of action, 73
chunking, 22–23, 22*f*, 23*f*, 39
Clark, Andy, 50
Clark, Ruth, 5
closing (in learning experience design), 93–94
coaching, 81
cocktail party phenomenon, 21, 28
cognition
  distributed, 54*f*
  meta-, 78–80
Cognition and Technology Group (Vanderbilt University), 102
Cognition in the Wild (Hutchins), 53
cognition stores, 13, 13*f*
"Cognitive Apprenticeship" (Collins et al.), 92, 97
cognitive architecture, 31
  and automation, 40–41
  and context, 36–38
  and feedback, 31–32
  and load, 39–40
  and media affects, 44–48
  and misconceptions, 35–36
  and models, 33–35
  and priming for action, 41
  and retrieval, 42–43
  and scaffolding, 44
Cognitive Flexibility Theory, 35
cognitive label (cognitive science), 61
cognitive load, 39, 39*f*, 40*f*
cognitive psychology, 2
cognitive science, 3, 11, 61

coherence, thematic, 73
collaboration, 81
collective learning, 81
Collins, Allan, 92, 97
color blindness, 16
The Comic Toolbox (Vorhaus), 71
community of practice, 58–59
compiling, 28
Component Display Theory, 4
computer games, 73
conative label (cognitive science), 61
concepts (in learning experience design), 89–91, 90*f*
concrete examples, 38
confidence (in ARCS model), 67, 68
connectionist model, 49
Conscientiousness (C), 63*f*
consequences, 96
constructivist psychology, 2–3
context
    and cognitive architecture, 36–38, 37*f*, 38*f*
    in learning experience design, 88, 90–95, 90*f*
    in Workplace of the Future, 101
corrective feedback, 32
coupling, 74
creativity, systematic, 99
criteria, 85, 88
Cross, Jay, 100
Csikszentmihalyi, Mihaly, 68
culture, 74–76, 75*f*
curriculum, 105–108, 105–108*f*

D

Deci, Edward, 66
decision making, 51, 51*f*, 66, 97
declarative knowledge, 26
declarative memory, 26
deliberate practice, 43
Design for How People Learn (Dirksen), 94
Design of Everyday Things (Norman), 46
desirable difficulty, 43
digital technology, 53, 54*f*, 79–80
directive feedback, 32
direct manipulation, 74, 102–103
Dirksen, Julie, 94
distributed cognition, 54*f*
diversity, 75
double loop learning, 79
dramatic tension, 69, 70*f*
Draper, Steve, 74
Duckworth, Angela, 83
Dunning-Kruger effect, 52
Dweck, Carol, 84

E

Ebbinghaus, Hermann, 2, 42
Edmundson, Amy, 74
elaboration, 24–25, 24*f*
e-learning, 65, 94–96, 95*f*, 99–100
eLearn Magazine, 108
emergent goals, 73
Emotional Design (Norman), 64
Emotionality (E), 63*f*
enculturation, 97
energy spectrum, 16
engagement, 63–64, 72–74, 109
Engaging Learning (Quinn), 72, 99
epistemic feedback, 32
Ericsson, Anders, 43
evaluation
    in mega-cognitive regulation, 81, 82
    self-, 85
Evidence-Informed Learning Design (Neelen and Kirschner), 32, 81
examples
    concrete vs. abstract, 38
    in learning experience design, 91–92, 91*f*
experience trajectory, 69–70, 70*f*. *See also* learning experience design
experiments, 6
exploration, 102, 103*f*
extrinsic motivation, 65–66
Extroversion (X), 63*f*
eyes, 15

F

far transfer, 59, 93
feedback, 31–32, 98
    body, 17
    and models, 33
    and practice, 92
    in Workplace of the Future, 103–104
fixed mindset, 84

flow, 68–69, 69*f*
forgetting curve, 42, 42*f*
formal learning, 82, 82*f*
frames, 26
free energy principle, 59
Friston, Karl, 59

G

games, 66, 67, 69
 computer, 73
 direct manipulation in, 74
 for effective learning, 98–99
Garvin, David, 74
Gawande, Atul, 51
Gino, Francesca, 74
goals
 clear or emergent, 73
 for learning, 98
 in Workplace of the Future, 100
Greeks, ancient, 2, 77
grit, 83
growth mindset, 84

H

hands, 17
The Hero's Journey (Campbell), 74
HEXACO model, 62, 63*f*, 83–84
highlighting, 45
Holum, Ann, 92
Honesty and Humility (H), 63*f*
Hornstein, Norbert, 55
How People Learn (Shackleton-Jones), 63
humor, 71–72
Hutchins, Ed, 53

I

ID2, 4
images, 13
individualized challenge, 96
informal learning, 82, 82*f*
Informal Learning (Cross), 100
information processing, 11, 19
innovation, 80
input-output inter-referentiality, 74
instructional design, 4–5
Internet Time Alliance (ITA), 100
intrinsic motivation, 65–66
introduction (in learning experience design), 88–89
investing smartly, 110–111
ITA (Internet Time Alliance), 100

J

Jarche, Harold, 78, 109
journals, 6, 7

K

Kahneman, Daniel, 51, 51*f*
Keller, John, 67, 68
Kieras, David, 33
Kirschner, Paul, 5, 32, 81
knowledge
 declarative vs. procedural, 26
 Dunning-Kruger effect and level of, 52
Koster, Raph, 69
Kuhn, Thomas, 6

L

labels, 39
language, 13, 16
Laurel, Brenda, 73
Lave, Jane, 97
leadership, 13
learning
 attitudes toward, 83–84
 collective, 81
 double loop, 79
 e-, 65, 94–96, 95*f*, 99–100
 formal vs. informal, 81, 82*f*
 learning about, 80–81 (*See also* meta-learning)
 machine, 50
 mobile, 45
 neuro-, 11
 self-directed, 81
 self-regulated, 81–83
 situated, 97
 social, 55–59, 56*f*, 57*f*

Learning Development Accelerator, 108
learning experience design, 87–96
closing component of, 93–94
concepts component of, 89–91
examples component of, 91–92
introduction component of, 88–89
objectives component of, 88
practice component of, 92–93
Learning Guild, 108
learning science
conducting, 5–6
definition of, 2
features of, 2–3
need for, 1
value of, 4–5
Learning Solutions magazine, 108
learning-to-learn skills, 83
Learnnovators, 99–100
load, cognitive, 39, 39*f*, 40*f*
long-term memory, 13, 24–27, 24*f*

M

machine learning, 50
Mager, Robert, 85, 88
Make it Learnable series, 45
Malamed, Connie, 46
manipulation, direct, 74, 102–103
marketing, 21
massive open online courses (MOOCs), 65
McClelland, Jay, 49
McTighe, Jay, 54
meaningfulness, 95
media affects, 44–48, 46*f*, 47*f*
memory, 2
and attention, 22
and chunking, 22–23, 22*f*, 23*f*
declarative vs. procedural, 26
long-term, 13, 24–27, 24*f*
types of, 26*f*
working, 20*f*, 23, 28
mentoring, 81
Merrill, David, 4
meta-cognition, 78–80
meta-learning, 77–86, 107–108, 108*f*
and attitudes toward learning, 83–84
and cognition, 78–80
and reflection, 84–85
and self-regulated learning, 81–83
and 21st-century skills, 85–86
metaphors, as models, 35
mind-mapping, 80, 80*f*
mindset, fixed vs. growth, 84
Minsky, Marvin, 26
misconceptions, 35–36
mixing it up, 92
mobile learning, 45
models, 33–35, 33*f*, 34*f*, 90–91
monitoring, 77, 81
MOOCs (massive open online courses), 65
Moser, Rob, 72
motivation, 65–67, 66*f*, 95
motor actions, 28–29, 28*f*
muscle memory, 26

N

Neelen, Mirjam, 5, 32, 81
neural net model, 49
neurolearning, 11
neurons, 11–13, 42
Nielsen, Jakob, 45
noises, 16
noncognitive aspects of learning, 61–76
anxiety, 64–65
challenge, 68–69
confidence, 68
culture, 74–76
engagement, 63–64, 72–74
experience trajectory, 69–70
humor, 71–72
motivation, 65–67
personality traits, 62–63
Norman, Donald, 46, 64
note taking, 80
novelty, 74

O

objectives (in learning experience design), 88
OCEAN scale, 62, 64
Openness to Experience (O), 63*f*
overgeneralizing, 27

P

Palincsar, Annemarie Sullivan, 97
paradigm shifts, 6

parallel distributed processing, 49
Pavlov, Ivan, 26
Pavlovian conditioning, 2
PBL, 66
Peak (Ericsson), 43
performance, 85, 88, 95
performance support, 53
personality traits, 62, 63*f*, 83–84
Personal Knowledge Mastery model, 78, 79*f*, 109
phenotypic plasticity, 55
photos, 47
Pinball Construction Set (game), 74
pixels, 12, 12*f*
planning, in mega-cognitive regulation, 81
play, 66, 67
podcasts, 108
practice, 42, 43, 92–93
priming for action, 41, 41*f*
procedural knowledge, 26
procedural memory, 26
psychology, 2–3

Q

qualitative studies, 5
quantitative studies, 5, 6

R

recall, recognition vs., 25
reflection
    learning as, 98
    reflecting on, 84–85
    time for, 75
regulation, meta-cognitive, 81
rehearsal, 24
reinforcement schedules, 2, 3*f*
relevance
    in ARCS model, 67
    to goal, 73
    in Workplace of the Future, 102
retrieval, 24*f*, 25–27, 42–43, 42*f*
Richter, Matthew, 66
role playing, 66, 72
Rumelhart, David, 26, 49
Ryan, Richard, 66

S

safety, 75–76
Sagan, Carl, 109
satisfaction (in ARCS model), 67
scaffolding, 44, 80
Scardamalia, Marlene, 97
Schank, Roger, 26, 27
schemas, 26
Schoenfeld, Alan, 92, 97
scientific method, 6
seek-sense-share framework (Personal Knowledge Mastery model), 78, 79*f*
self-determination theory, 66*f*
self-directed learning, 81
self-esteem, 64
self-evaluation, 85
self-regulated learning, 81–83
senses, 14–18
sensory gaps, 17–18
sensory homunculus, 14, 14*f*
sensory specificity, 20
sensory stores, 15*f*, 18–20
Serious eLearning Manifesto, 94–96, 95*f*
Shackleton-Jones, Nick, 63
Shank, Patti, 45
Shute, Valerie, 32
sight, 15–16
situated learning, 97
skills
    acquiring, 80
    learning-to-learn, 83
    21st-century, 85–86
skin, as sense organ, 17
smell, 16–17
SMEs (subject matter experts), 88
snap decisions, 51
"sniff" test, 109
Social Cognitive Theory (Bandura), 57
social learning, 55–59, 56*f*, 57*f*
sound, sense of, 16
spacing effects, 42, 42*f*, 43, 96
specificity, sensory, 20
speech, 16
Spiro, Rand, 35
statistical significance, 5, 5*f*
statistics, 5
stereotyping, 27
stimulus-response, 2

stores, cognition, 13, 13*f*
stores, sensory, 15*f*, 18–20
“strip it” step, 110
style, writing, 45
subject matter experts (SMEs), 88
supportive learning environment, 75*f*
surprise, 59
systematic creativity, 99

T

taste, 16–17
technology, digital, 53, 54*f*, 79–80
Thalheimer, Will, 94
thematic coherence, 73
theory, and experimentation, 6
A Theory of Fun (Koster), 69
Thiagi Group, 66
Things That Make Us Smart (Norman), 46
Thinking, Fast and Slow (Kahneman), 51
Thorn, Kevin, 48
time for reflection, 75
touch, sense of, 17
trajectory of experience, 69–70, 70*f*
transfer, 98
  context and, 37, 37*f*
  far, 59, 93
21st-century skills, 85–86

U

Understanding by Design (Wiggins and McTighe), 54
University of Southern California, 40

V

Vanderbilt University, 102
videos, 47
visible spectrum, 16
Vorhaus, John, 71
Vygotsky, Lev, 58, 69, 101

W

web, writing for the, 45
whitespace, using, 45
Wiggins, Grant, 54
WIIFM, 67, 89
Willingham, Daniel, 109
working memory, 20*f*, 23, 28
Workplace of the Future (demo), 100–105, 100*f*, 101*f*, 103–105*f*
World War II, 4
writing, 45

Y

Yerkes-Dodson law, 2, 64, 65*f*

Z

zone of proximal development (ZoPD), 58, 69, 101

About the Author

Clark Quinn assists Fortune 500, education, government, and not-for-profit organizations in integrating learning science and engagement into their design processes. He has a track record of innovation, and has consistently led development of advanced uses of technology, including mobile, performance support, and intelligently adaptive learning systems, as well as award-winning online content, educational computer games, and websites. Previously, Clark headed research and development efforts for Knowledge Universe Interactive Studio, and held management positions at Open Net and Access CMC, two Australian initiatives in internet-based multimedia and education.

Clark is a recognized scholar in the field of learning technology, having held positions at the University of New South Wales, the University of Pittsburgh's Learning Research and Development Center, and San Diego State University's Center for Research in Mathematics and Science Education. He earned a PhD in cognitive psychology from the University of California, San Diego, after working for DesignWare, an early educational-software company.

Clark keynotes both nationally and internationally and is the author of numerous articles and chapters, as well as the books *Engaging Learning: Designing e-Learning Simulation Games, Designing mLearning: Tapping Into the Mobile Revolution for Organizational Performance, The Mobile Academy: mLearning for Higher Education, Revolutionize Learning & Development: Performance & Innovation Strategy for the Information Age*, and *Millennials, Goldfish & Other Training Misconceptions: Debunking Learning Myths and Superstitions*. In 2012 he was awarded the eLearning Guild's first Guild Master designation. He blogs at Learnlets.com, tweets as @quinnovator, and serves as executive director of Quinnovation.

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Learning Science for Instructional Designers: From Cognition to Application distills the current scope of learning science into an easy-to-read primer.

Good instructional design makes learning as simple as possible by removing distractions, minimizing the cognitive load, and chunking necessary information into digestible bits. But our aim must go beyond enabling learners to recite facts to empowering them to make better decisions—decisions about what to do, when, and how. Written by Clark N. Quinn, author of *Millennials, Goldfish & Other Training Misconceptions: Debunking Learning Myths and Superstitions,* this book prepares you to design learning experiences that ensure retention over time and transfer to the appropriate situations. It will spark your thinking about how to use these concepts and more in your daily work.

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—PATTI SHANK, LEARNING SCIENCE RESEARCHER, AUTHOR, AND FACILITATOR

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—WILL THALHEIMER, RESEARCH-INSPIRED LEARNING CONSULTANT

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