The Science Behind ECHO

www.swissvbs.com

SWISSVBS

Three factors have shaped the development of ECHO into the gold standard in corporate training reinforcement:

1. Extensive empirical research conducted by leading cognitive psychologists in the field of learning, memory, and retention
2. Insights that SwissVBS has gained over the past 15 years in serving the corporate learning market
3. Input of an early adopter and a key SwissVBS client: GE

Let's take a few minutes to look at the science behind ECHO.

The Forgetting Curve

We know that learners almost immediately forget approximately 70 percent of what they've just learned. The remaining knowledge gradually disappears, albeit more slowly. The Forgetting Curve is as real in corporate learning as in other settings. The key challenge to improving the way we learn is finding a way to interrupt the forgetting process. **[1]**

Background

To effectively target the forgetting curve, ECHO is based on seven design principles, each backed by an extensive body of empirical research and scientific studies. Collectively, these principles represent the underlying philosophy that has shaped the evolution of ECHO. The product leverages mobile, cloud, and AI technologies to tackle effectively the memory loss that occurs after a training program.

A brief description of each principle is offered below. The book *Make It Stick*, which provides the basis for these principles, gives a comprehensive summary of the latest empirical research on durable learning and retention.

The main scientific studies that support each principle are referenced in square brackets. These references are listed at the end of the article.

The empirical studies that form the scientific basis of ECHO fall into the discipline of *cognitive psychology*. Cognitive psychology is the scientific study of mind and mental function, including learning, memory, attention, and retention. Cognitive psychologists explore how mental processes affect behavior. Much of the work derived from cognitive psychology has been integrated into other modern disciplines, including educational psychology.

Design Principles

Principle 1: Retrieval Practice Stops the Act of Forgetting

The act of retrieving knowledge from memory both strengthens and builds new neuro-pathways in the brain that make it easier to recall that information in the future. Active *retrieval practice* is one of the most effective ways to make what we have learned more accessible to us when we need it. **[3] [4] [5]**

Principle 2: Retrieval Practice is Better than Relearning

Relearning is not as effective as retrieval practice. Relearning has three strikes against it. It is time consuming, it doesn't result in durable memory, and it often involves an unwitting self-deception, as growing familiarity with the text comes to feel like mastery of the content (fluency is mistaken for learning). The number of hours immersed in rereading is not a measure of mastery. **[2]**

Learners whose study strategies emphasize rereading, but not self-testing or retrieval practice, show overconfidence in their mastery. Learners who have taken part in retrieval practices have a double advantage over those who have not: a more accurate sense of what they know and don't know, and the strengthening of learning that accrues from retrieval practice. **[18] [19]**

Principle 3: Retrieval Practice is Better than Massed Learning

Massed learning (cramming) leads to short-term retention but results in faster forgetting compared with retrieval practice. Gains achieved during massed learning are transitory and fade away quickly. **[10] [11] [12]**

Principle 4: Retrieval Practice Needs to be Effortful

When learning is harder, it's stronger and lasts longer. Where more cognitive effort is required for retrieval, there are greater retention results. Even a single retrieval practice can produce a large improvement in retention, and gains in learning continue to increase as the number of retrieval practices increases. **[16] [17] [18] [20] [21] [22] [23]**

Principle 5: Retrieval Practice Needs to be Spaced Out

Multiple sessions of retrieval practice are generally better than one, especially if the sessions are spaced out. **[6] [7]**

To be most effective, retrieval must be repeated again and again, in spaced-out sessions, so that the recall, rather than a mindless recitation, requires some cognitive effort. **[4] [5] [9]**

When retrieval practice is spaced out and broken into separate periods, allowing for some forgetting to occur between tests, it leads to stronger long-term retention than when it is massed. **[8] [24] [25]**

What should be the time separation between practices? Enough so that practice doesn't become mindless repetition. Or in other words, enough time so that a little forgetting can set in. A little forgetting between practice sessions can be a good thing, if it leads to more effort in practice. Waiting too long will result in so much forgetting that retrieval essentially involves relearning the material. The time periods between retrieval practice sessions allow our memory to consolidate. Sleep plays a large role in memory consolidation as well, so mapping practices with at least a day in between sessions is considered ideal.

Principle 6: Delayed Feedback is More Effective

Giving feedback on wrong answers to retrieval practice questions strengthens retention more than testing alone. **[13] [14] [15]**

Delaying feedback briefly produces better long-term learning than immediate feedback. **[13] [14] [15]**

Principle 7: Retrieval Practice Needs to Be Interleaved

Interleaving the practice of two or more subjects or skills is also a more potent alternative to massed practice. Interleaving two or more subjects during practice provides a form of spacing and requires the learner to exert more effort. The learning from interleaved practice feels slower than learning from massed practice. Trainers and learners both sense the difference. Learners can see that their grasp of each concept is achieved more slowly, and the long-term advantage is not apparent to them. They may find it confusing: they're just starting to get a handle on new material and don't feel on top of it yet when they are forced to switch. Trainers avoid it because it feels sluggish. But the research shows unequivocally that mastery and long-term retention are much better if practices are interleaved rather than massed. **[26]**

SWISSVBS

Empirical Research References

[1] **Memory: A contribution to experimental psychology (Link)**

Author: Hermann Ebbinghaus

Publication: Memory: A contribution to experimental psychology (New York: Dover, 1964)

Summary: The first scientific work on forgetting curves. Ebbinghaus is often viewed as the "father" of the scientific study of memory.

[2] **Metacognitive strategies in student learning: do students practice retrieval when they study on their own? (Link)**

Author: Karpicke JD, Butler AC, Roediger HL 3rd

Publication: Memory 17 (2010), 471–479

Summary: This study showed that the amount of study time is no measure of mastery.

[3] **Cognition, memory, and education (Link)**

Author: M. A. McDaniel & A. A. Callender

Publication: H. L. Roediger, Cognitive Psychology of Memory, vol. 2 of Learning and Memory: A Comprehensive Reference (Oxford: Elsevier, 2008), pp. 819–844

Summary: This study illustrated the value of testing as a learning tool.

[4] **Recitation as a factor in memorizing (Link)**

Author: A. I. Gates

Publication: Archives of Psychology 6 (1917)

Summary: This was one of the first large-scale studies to document the phenomenon that taking a test or reciting material appearing in didactic texts improved retention.

[5] **Studies in retention (Link)**

Author: H. F. Spitzer

Publication: Journal of Educational Psychology 30 (1939), 641–656

Summary: This was another large-scale study to document the effect of taking tests and reciting material on retention.

[6] **The effects of presentation and recall of material in free-recall learning (Link)**

Author: E. Tulving

Publication: Journal of Verbal Learning and Verbal Behavior 6 (1967), 175–184

Summary: This study showed that memory is a limited-capacity retrieval system in which the limit is set by the number, but not by the nature of the contents, of accessible memory units.

[7] **Disparate effects of repeated testing: Reconciling Ballard's and Bartlett's results (Link)**

Author: M. A. Wheeler & H. L. Roediger

Publication: Psychological Science 3 (1992), 240–245

Summary: This study showed that shorter intervals between successive retrieval practices results in better long term retention. The study showed when these intervals are long, forgetting occurs.

[8] **On interpreting the effects of repetition: Solving a problem versus remembering a solution (Link)**

Author: L. L. Jacoby

Publication: Journal of Verbal Learning and Verbal Behavior 17 (1978), 649–667

Summary: This laboratory experiment demonstrated that the means of obtaining the solution influences retention performance.

[9] **Test-enhanced learning in the classroom: Long-term improvements from quizzing (Link)**

Author: H. L. Roediger, P. K. Agarwal, M. A. McDaniel, & K. McDermott

Publication: Journal of Experimental Psychology: Applied 17 (2011), 382–395

Summary: This study found that quizzing produced a significant improvement relative to no quizzing or directed review of target concepts on unit exams and on cumulative semester and end-of-year exams.

[10] **Test-enhanced learning in a middle school science classroom: The effects of quiz frequency and placement (Link)**

Author: M. A. McDaniel, P. K. Agarwal, B. J. Huelser, K. B. McDermott, & H. L. Roediger

Publication: Journal of Educational Psychology 103 (2011), 399–414

Summary: This study demonstrated that quizzing produced a significant improvement relative to no quizzing.

[11] **Test-enhanced learning: Taking memory tests improves long-term retention (Link)**

Author: H. L. Roediger & J. D. Karpicke

Publication: Psychological Science 17 (2006), 249–255

Summary: This study that showed that recall of studied prose passages produced better 2-day and one-week retention than the restudy of the same passages.

[12] **How recall facilitates subsequent recall: A reappraisal (Link)**

Author: C. P. Thompson, S. K. Wenger, & C. A. Bartling

Publication: Journal of Experimental Psychology: Human Learning and Memory 4 (1978), 210–221

Summary: This experiment showed that massed study was better than practicing retrieval on an immediate test but not a delayed test.

[13] **Feedback enhances the positive effects and reduces the negative effects of multiple-choice testing (Link)**

Author: A. C. Butler & H. L. Roediger

Publication: Memory & Cognition 36 (2008), 604–616

Summary: This experiment showed that feedback strengthens the effects of testing and that feedback may be more beneficial when it's slightly delayed. The authors also showed that that feedback enhances the positive effects and reduces the negative effects of multiple-choice testing.

[14] **Knowledge of results and motor learning: A review and critical reappraisal (Link)**

Author: A. W. Salmoni, R. A. Schmidt, and C. B. Walter

Publication: Psychological Bulletin 95 (1984), 355–386

Summary: This study found that frequent immediate feedback can be detrimental to long-term learning—even though it helps immediate performance—because it provides a crutch during practice that is no longer present on a delayed test.

[15] **Examining the testing effect with open- and closed-book tests (Link)**

Author: P. K. Agarwal, J. D. Karpicke, S. H. K. Kang, H. L. Roediger, & K. B. McDermott

Publication: Applied Cognitive Psychology 22 (2008), 861–876

Summary: This experiment demonstrated taking either open or closed book tests, with feedback, enhanced long-term retention relative to conditions in which subjects restudied material or took a test without feedback.

[16] **Test format and corrective feedback modify the effect of testing on long-term retention (Link)**

Author: S. H. Kang, K. B. McDermott, H. L. Roediger

Publication: European Journal of Cognitive Psychology 19 (2007), 528–558

Summary: This study showed that the testing effect is more robust when more effort is required for retrieval.

[17] **Testing the testing effect in the classroom (Link)**

Author: M. A. McDaniel, J. L. Anderson, M. H. Derbish, & N. Morrisette

Publication: European Journal of Cognitive Psychology 19 (2007), 494–513

Summary: This study showed that testing effect is more robust when more effort is required for retrieval.

[18] **Both multiple-choice and short-answer quizzes enhance later exam performance in middle and high school classes (Link)**

Author: K. B. McDermott, P. K. Agarwal, L. D'Antonio, H. L. Roediger, & M. A. McDaniel

Publication: Journal of Experimental Psychology: Applied 2014 Mar;20(1):3-21

Summary: This study showed that multiple-choice tests, especially when given repeatedly, can have as much positive effect on learning as a short-answer tests.

[19] **Test-potentiated learning: Distinguishing between the direct and indirect effects of tests (Link)**

Author: K. M. Arnold & K. B. McDermott

Publication: Journal of Experimental Psychology: Learning, Memory and Cognition 39 (2013), 940–945

Summary: This study showed that unsuccessful retrieval attempts enhance the effectiveness of subsequent restudy.

[20] **The exam-a-day procedure improves performance in psychology classes (Link)**

Author: F. C. Leeming

Publication: Teaching of Psychology 29 (2002), 210–212

Summary: This study demonstrated the long-term benefits of more frequent testing.

[21] **Retrieving essential material at the end of lectures improves performance on statistics exams (Link)**

Author: K. B. Lyle & N. A. Crawford

Publication: Teaching of Psychology 38 (2011), 94–97

Summary: This study demonstrated that retrieving essential material at the end of lectures improves learners' performance.

[22] **The power of testing memory: Basic research and implications for educational practice (Link)**

Author: H. L. Roediger & J. D. Karpicke

Publication: Perspectives on Psychological Science 1 (2006), 181–210

Summary: This paper represents a comprehensive review of laboratory and classroom studies over nearly one hundred years of research, showing that testing can be a powerful learning tool.

[23] **Ten benefits of testing and their applications to educational practice (Link)**

Author: H. L. Roediger, M. A. Smith, & A. L. Putnam

Publication: J. Mestre & B. H. Ross (eds.), Psychology of Learning and Motivation (San Diego: Elsevier Academic Press, 2012)

Summary: This study explores many benefits of frequent testing and the direct benefits of retrieval practice.

[24] **Distributed practice in verbal recall tasks: A review and quantitative synthesis (Link)**

Author: N. J. Cepeda, H. Pashler, E. Vul, J. T. Wixted, & D. Rohrer

Publication: Psychological Bulletin 132 (2006), 354–380

Summary: This paper is a review of the literature on the spacing effect in memory.

[25] **Teaching surgical skills: What kind of practice makes perfect? (Link)**

Author: Carol-Anne E. Moulton, A. Dubrowski, H. MacRae, B. Graham, E. Grober, & R. Reznick

Publication: Annals of Surgery 244 (2006), 400–409

Summary: This study showed that better retention results from spaced instruction, as compared to cramming instruction into one intensive session.

[26] **The shuffling of mathematics problems improves learning (Link)**

Author: D. Rohrer & K. Taylor

Publication: Instructional Science 35 (2007), 481–498

Summary: This laboratory experiment demonstrated that clustering practice problems by type produced inferior performance on a final test compared to shuffling practice problems from different problem types.

MORE ABOUT SWISSVBS:

As a leader in training reinforcement solutions, we empower you with our award-winning ECHO app to improve your employees' retention and performance. Our dynamic platform and training reinforcement experts will maximize your learning investments and equip you with powerful data to transform your learning initiatives.

For over 16 years, our customers have relied on our innovative products and services to improve employee performance and business outcome in industries as diverse as health, retail, insurance, manufacturing, and finance.

Find out more at: ***www.swissvbs.com/en/echo***
or email ***info@swissvbs.com***

TORONTO

333 Adelaide St. West,
Suite 200
Toronto ON, Canada
+1 416 848 3744

ST. GALLEN

Winkelriedstr. 35
9000 St.Gallen
Switzerland
+41 71 845 5936

MUNICH

Osterwaldstr. 10 / Building G19
– 2nd floor
80805 München, Germany
+49 89 307 68 895