The Science Behind ECHO

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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]
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
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 of accessible memory units. It provides a crutch during practice that is no longer present on a delayed test.

[5] Studies in retention (link)
Author: H. E. Spiner
Publication: Journal of Educational Psychology 30 (1939), 641–656
Summary: This study showed that shorter intervals between successive retrieval practices result in better long-term retention. The study showed that retrieval when they study on their own?

[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 the amount of study time is no measure of mastery.

[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
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.

Author: H. L. Roediger & J. D. Karpicke
Publication: Psychological Science 17 (2006), 249–255
Summary: This experiment showed that recall of studied prose passages produced better 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.

[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 study 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 study showed 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.

[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 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 feedback enhances the positive effects and reduces the negative effects of multiple-choice testing.

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

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.

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.

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.

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.

Ten benefits of testing and their applications to educational practice. (Link)

Author: H. L. Roediger, M. A. Smith, & A. L. Putnam
Summary: This study explores many benefits of frequent testing and the direct benefits of retrieval practice.

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

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.

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.

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