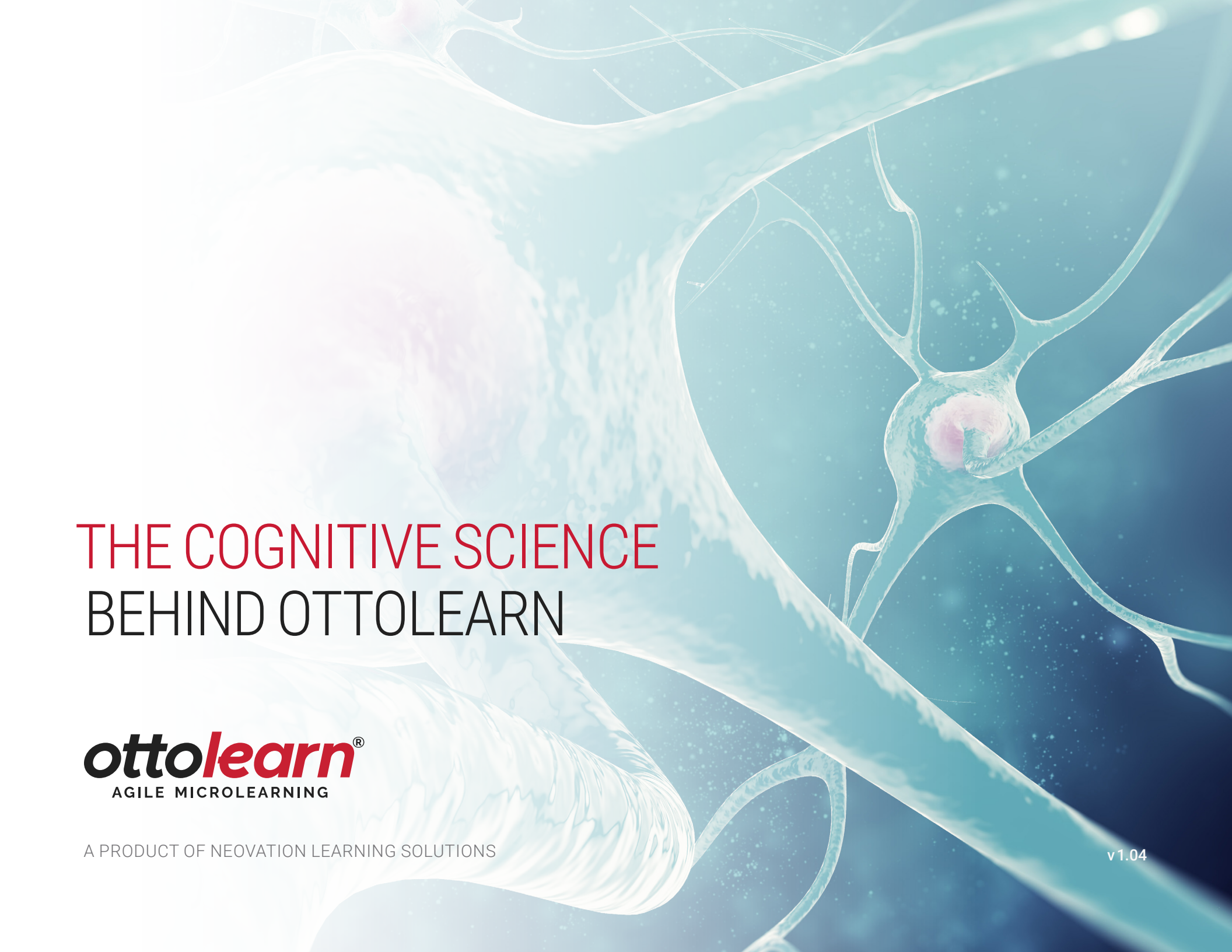

THE COGNITIVE SCIENCE BEHIND OTTOLEARN

ottolearn®
AGILE MICROLEARNING

A PRODUCT OF NEOVATION LEARNING SOLUTIONS

v1.04

Neovation.com

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***Dan**, the founder of Neovation Learning Solutions, is obsessed with improving digital learning and training. A frequent and engaging speaker at eLearning events, Dan is sure to make learners and L&D professionals alike question long-held beliefs and stretch their thinking about how people learn and retain information.*

CONTENTS

OttoLearn combines adaptive training with microlearning principles in order to first raise the learner's level of knowledge and then ensure retention. Personalized training is a powerful and effective approach that assesses an individual's knowledge and then develops an optimal training plan unique to that learner. Adaptive training goes one step further by continuously modifying the training plan to adapt to the performance of the learner.

INTRODUCTION

Disruptive technologies are **critical** to growth and success. When disruptive technologies are introduced, there is a dramatic shift in the way things are done. More often than not, these transformations lead to new solutions, advanced ideas, and increased productivity and profit. For example, cars were disruptive to the blacksmithing industry, and self-driving cars will completely disrupt how we buy and use cars.

Forward-thinking organizations **overcome their fear** of the new or different and actively seek disruptive technologies to fuel their growth.

A BRIEF HISTORY OF ADAPTIVE TRAINING

In the 1960s, when behavior scientists and educators first started experimenting with computer-based training (CBT), they focused on using computers to deliver **personalized training**. The fact that a computer could personalize training for each learner, by adapting to the learners' areas of strength and weakness, was seen as the major advantage of CBT.

One of the first adaptive training systems delivered math drills to students over touch-tone phones[1]. Students participating in these adaptive practice exercises **outperformed their peers**.

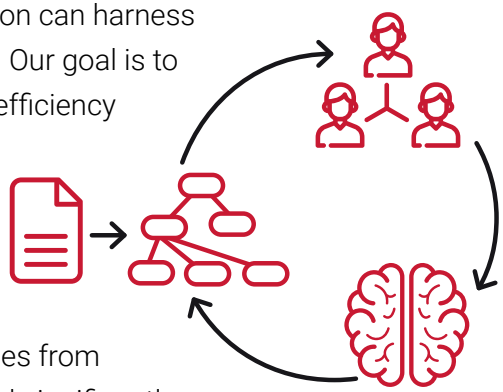
In the decades since the birth of CBT, the mass adoption of online training through AICC and SCORM standards improved the interoperability of modules across learning platforms but at the cost of personalization. Every learner received essentially the same training experience.

As a result, adaptive training technology became comparably expensive and out of reach for all but the most affluent organizations — even though it was **much more effective** than non-personalized, standardized training modules.

[1] *https://en.wikipedia.org/wiki/Patrick_Suppes*

THE RETURN OF ADAPTIVE TRAINING

With OttoLearn, any organization can harness the power of adaptive training. Our goal is to improve training and learning efficiency by **making adaptive training available to everyone** — for the benefit of both the organization and the learner.



OttoLearn leverages key theories from cognitive science to rapidly and significantly improve initial learning and knowledge retention.

These theories include:

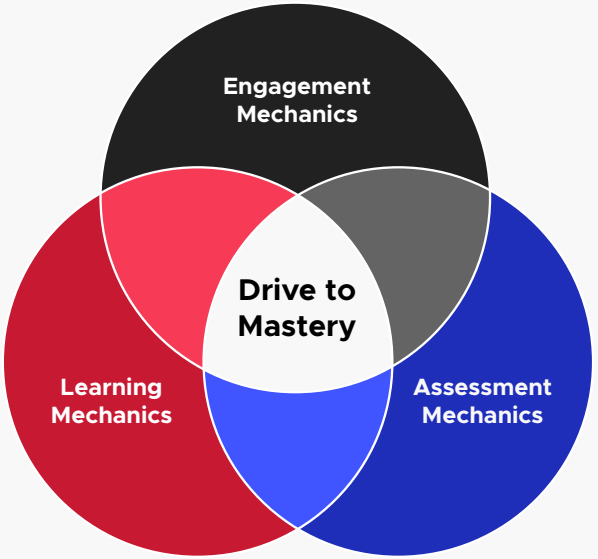
- Gamification of learning
- Deep encoding
- Instructional scaffolding
- The spacing effect
- Adaptive training
- The testing effect
- The interleaving effect
- Applied forgetting
- Formative feedback

> These learning theories, combined with big data analysis and machine learning techniques, deliver an **effective adaptive microlearning solution.**

GAMIFICATION OF LEARNING

Unlike game-based learning, where the instructional content is designed and implemented as a learning game, gamification applies game mechanics to eLearning content. This serves to engage learners and leverage their **intrinsic motivation** to achieve mastery on a topic.

OttoLearn leverages three types of game mechanics — engagement mechanics, learning mechanics, and assessment mechanics — which combine to create an atmosphere where the learner **wants to learn and achieve mastery.**



GAMIFICATION OF LEARNING

ENGAGEMENT MECHANICS

For learners to learn, they first must engage. But traditional learning platforms are designed around a one-and-done usage pattern, which can *decrease* learner engagement.

OttoLearn promotes high engagement by:

- Creating a daily training cadence, which normalizes training sessions into the learner's routine
- Delivering quick learning bursts of 2 minutes each
- Allowing the learner to do on-demand Mini Moments
- Providing continuous physical stimulation through interactivity
- Exercising content *a*t the edge of learners' knowledge
- Allowing the learner to engage with any device — mobile, tablet, or desktop

LEARNING MECHANICS

We define learning mechanics as the processes focused on having learners actually learn. When learners feel themselves learning, they are **motivated to continue learning**.

OttoLearn's learning mechanics include:

- Engaging learners in Activities immediately
- Providing learners with the **freedom to fail**
- Eliminating the need for pre-learning
- Providing a scaffolded learning experience
- Delivering learning sessions over time
- Interleaving content to increase learning efficiency

ASSESSMENT MECHANICS

With every interaction, OttoLearn builds a model of each learner's mastery, which it then uses to **adapt the delivery** of future Activities.

OttoLearn performs continuous assessment through multiple mechanisms, including:

- Focusing on mastery and competence versus completion
- Algorithmically determining the probability that a learner is guessing at an answer
- Allowing for self-assessment through confidence selection
- Providing learners with **formative feedback** to guide self-reflection
- Leveraging **applied forgetting** to optimize Concept selection

DEEP ENCODING

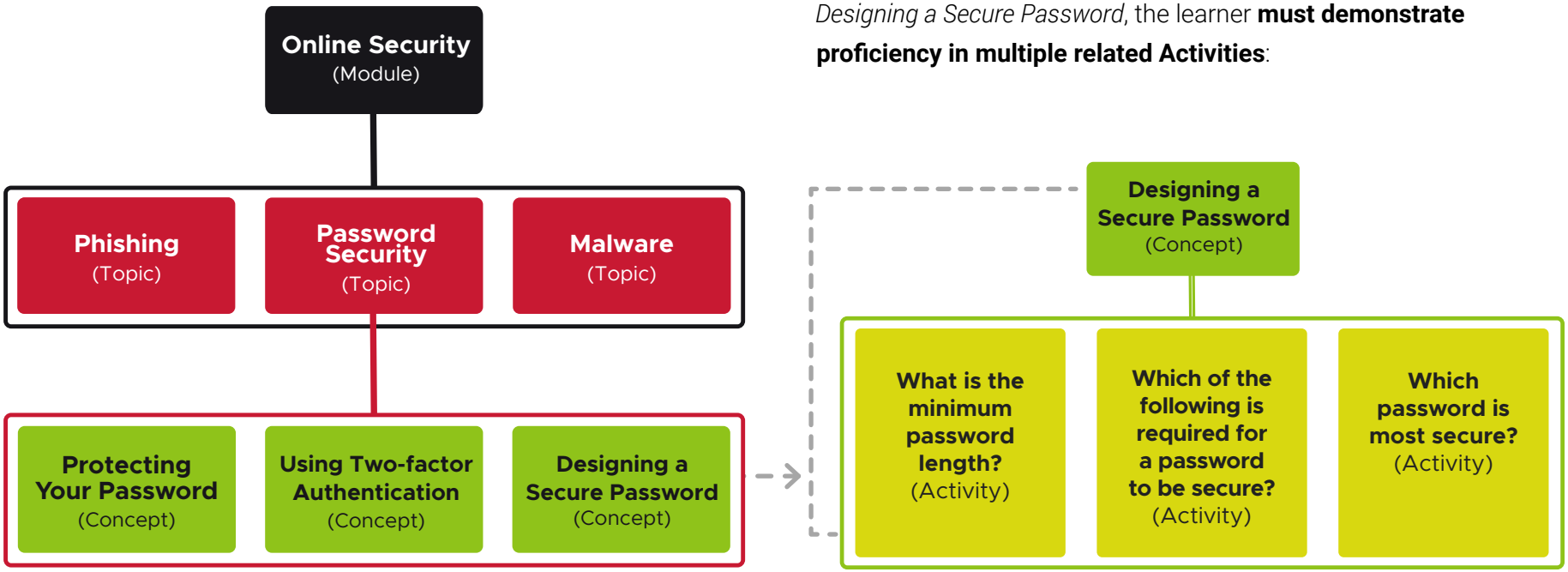
Unlike traditional eLearning, which organizes content in a linear format, OttoLearn organizes content as a **knowledge map.** The main container is a *Module*, which contains multiple *Topics*, each containing multiple *Concepts*. A Concept is a micro-sized unit of knowledge.

For instance, within a Module on online security, *Password Security* may be a Topic, and *Designing a Secure Password* may be a Concept within that Topic:

Since a Concept is more robustly learned when it is exercised from multiple perspectives and contexts, **multiple Activities are created for each Concept**. This enables OttoLearn to accurately gauge each learner's mastery of the knowledge within the Concept.

By mapping each Concept to multiple Activities, OttoLearn enables the learner to create multiple associations. Exercising the knowledge for each Concept through multiple vectors promotes **long-term retention.**

To move to a higher mastery level in a Concept, such as *Designing a Secure Password*, the learner **must demonstrate proficiency in multiple related Activities**:



INSTRUCTIONAL SCAFFOLDING

Historically, students would begin an apprenticeship with little knowledge, and through years of guided practice by a master, they would eventually reach mastery themselves. This is instructional scaffolding — **the framework of supporting and guiding learners to increase their mastery over time.**

In online training, a course might present and test learners' understanding of basic definitions first, then integrate knowledge of those concepts into practice activities. Finally, learners might be asked to apply the knowledge to solve complex scenarios.

OttoLearn **provides several methods** of instructional scaffolding, allowing you to leverage advanced instructional techniques, such as anchored instruction, to bring the learner from novice to master.

Scaffolding	Description
Mastery Prerequisite	The learner must first master one or more Modules, Topics, or Concepts prior to receiving more advanced content.
Explored Prerequisite	The learner must complete at least one Activity for a Concept, prior to receiving an Activity from a more advanced Concept.
Prioritized Importance	The instructional designer can set the relative importance for each Concept, to ensure that the most important Concepts are mastered first.

THE SPACING EFFECT

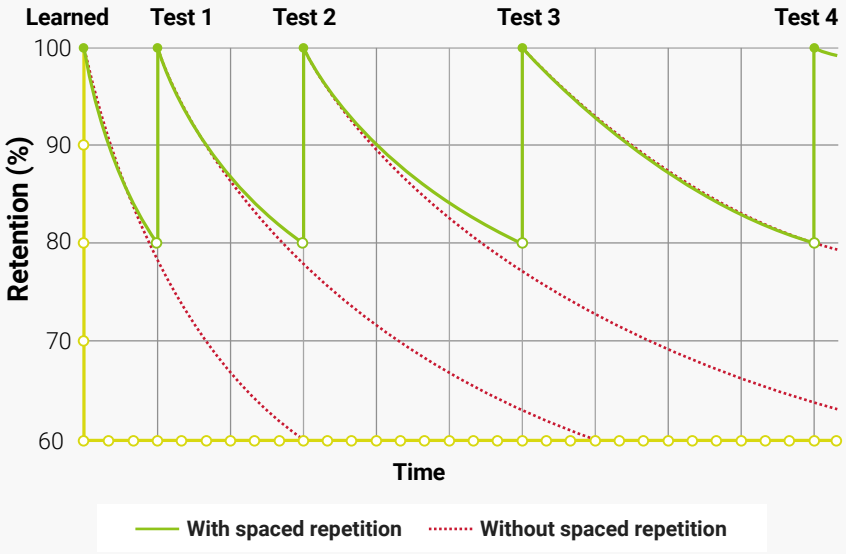
The spacing effect means that learning is **most efficient** when **studying is spread out over time**.

There are several theories seeking to explain the spacing effect, however, studies agree that it works[2] and has a significant impact on learning. One theory is **study-phase retrieval theory**, which postulates that if learners are exposed to the same information multiple times in a small timespan, the brain seeks to be efficient.

The brain stores infrequently accessed information in short-term memory. Information that is accessed more often is stored in longer-term memory. This is the brain's way of avoiding duplicate memories. Therefore, by exercising the information in OttoLearn at increasing intervals, learners are training their brains to store the information in **long-term memory**, facilitating retention.

As the learner completes Activities, OttoLearn will automatically determine the minimum amount of time that must elapse prior to presenting the learner with another Activity from the same Concept.

> You've probably experienced **short-term retention** after cramming for an exam — once you finish, **you quickly forget the material.**



Retention is improved through spaced repetition.

When a Concept is ready to be exercised by the learner (the minimum duration has elapsed), it is referred to as **valuable**. Proficient completion of valuable Activities increases a learner's Mastery Level for that Concept.

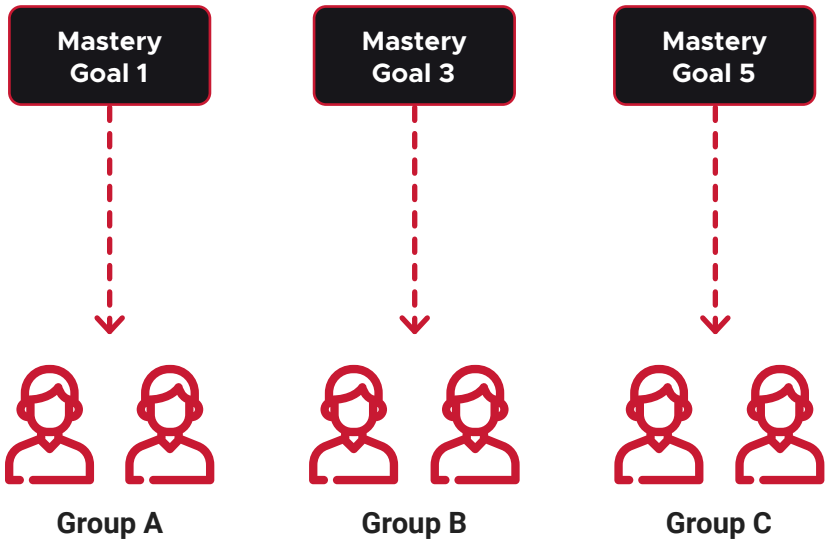
With each learning session, OttoLearn will seek to present the learner with as many valuable Activities as the learner can complete in a 2-minute session.

[2] *https://www.worklearning.com/wp-content/uploads/2017/10/Spacing_Learning_Over_Time__March2009v1_.pdf*

ADAPTIVE TRAINING

Personalized training is a powerful and effective approach that **assesses** a learner's knowledge and then **develops an optimal training plan** unique to that learner. Adaptive training goes one step further by continuously modifying the training plan to adapt to the performance of the learner.

In OttoLearn, each learner is assigned a Mastery Goal for a knowledge area (Module/Topic/Concept). **Different groups of learners may be assigned different Mastery Goals based on their job requirements.**



OTTOLEARN'S MASTERY LEVELS

5 Expert
Learners exhibit immediate recall and make virtually no errors.

4 Proficient
Learners exhibit accurate and rapid recall and make few errors.

3 Competent
Learners can predictably recall, but they require some thinking time and make occasional errors.

2 Aware
Learners can remember being exposed to the information, but they cannot predictably recall it.

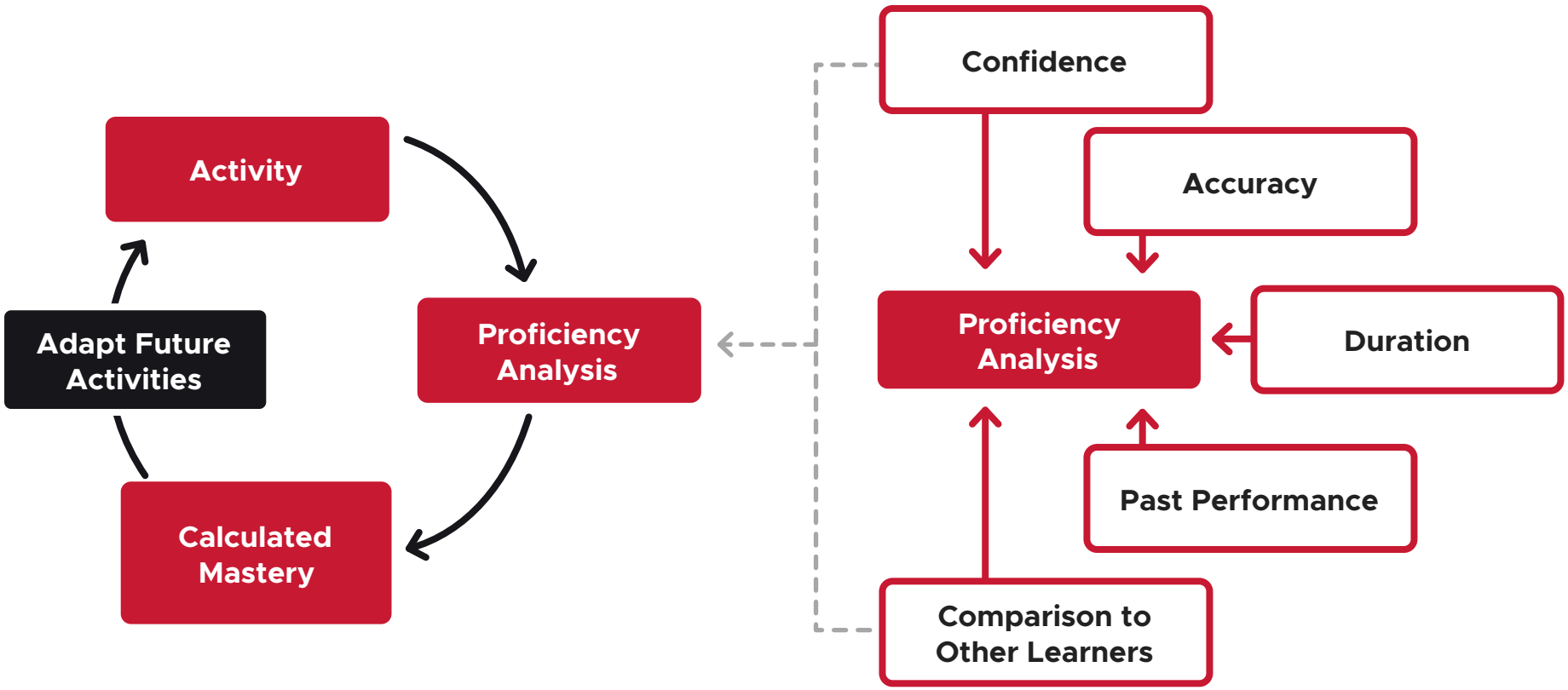
1 Novice
Learners are aware of what they don't know.

0 Unknown
Learners' knowledge is unknown.

ADAPTIVE TRAINING

Every time a learner completes an Activity, OttoLearn calculates a proficiency score by analyzing a number of data points (signals) including **accuracy**, **duration**, and **confidence**. If a learner has completed an Activity with sufficient proficiency, and the related Concept is in a valuable state, then the related Concept Mastery Level will increase.

> OttoLearn's adaptive algorithms are by themselves adaptive, using big data analysis to **become increasingly accurate over time.**



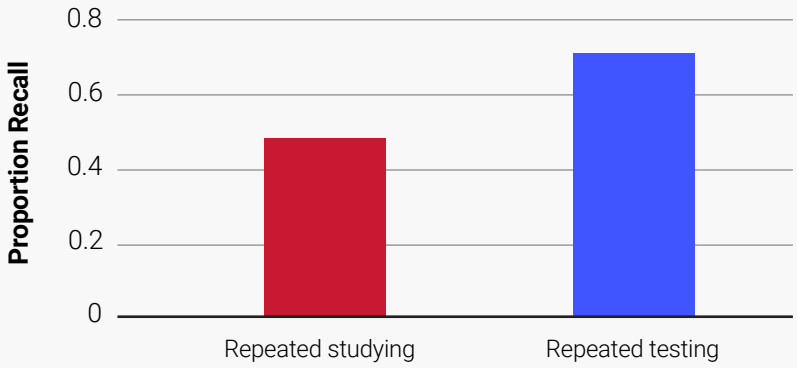
THE TESTING EFFECT

Also referred to as **retrieval practice** or **test-enhanced learning**, the testing effect states that the more often a learner retrieves information, the more likely it is to be stored in long-term memory.

The testing effect is most pronounced when the memory being retrieved is at the edge of exiting from short-term memory.

OttoLearn builds a model to indicate each learner's **Strength of Learning (SOL)** for a Concept. A learner who demonstrates Mastery quickly has a higher SOL than a learner who takes longer to demonstrate proficiency.

OttoLearn uses multiple factors, including the learner's SOL, to determine when and how often to present Activities on a particular Concept to each learner.

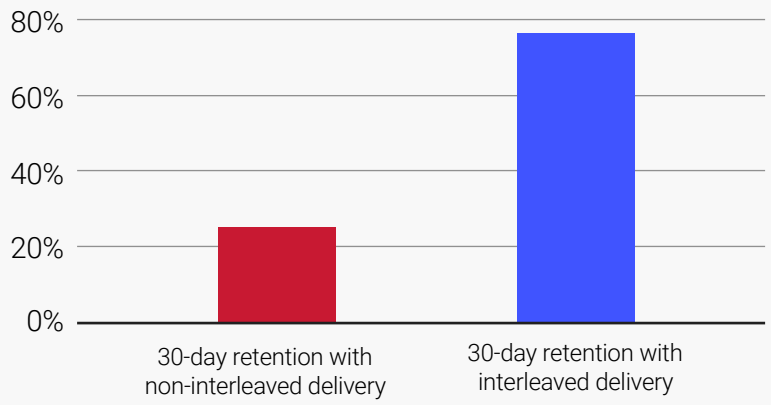


The more a learner retrieves a memory that is on the edge of forgetting, the stronger that memory becomes.

THE INTERLEAVED LEARNING EFFECT

Traditional eLearning delivers content in a "blocking" fashion: a particular learning session is focused on a single knowledge area and proceeds sequentially through related material.

However, if the delivery of material is mixed instead — for instance, knowledge area B, then area C, then area A — **the learner will more deeply encode the information in each knowledge area.**



Retention for content delivered through interleaved learning is much higher than for single content blocks.

When OttoLearn is selecting Activities to present to the learner, it selects the most valuable Activities across multiple Topics, **thus automatically leveraging the interleaved learning effect.**

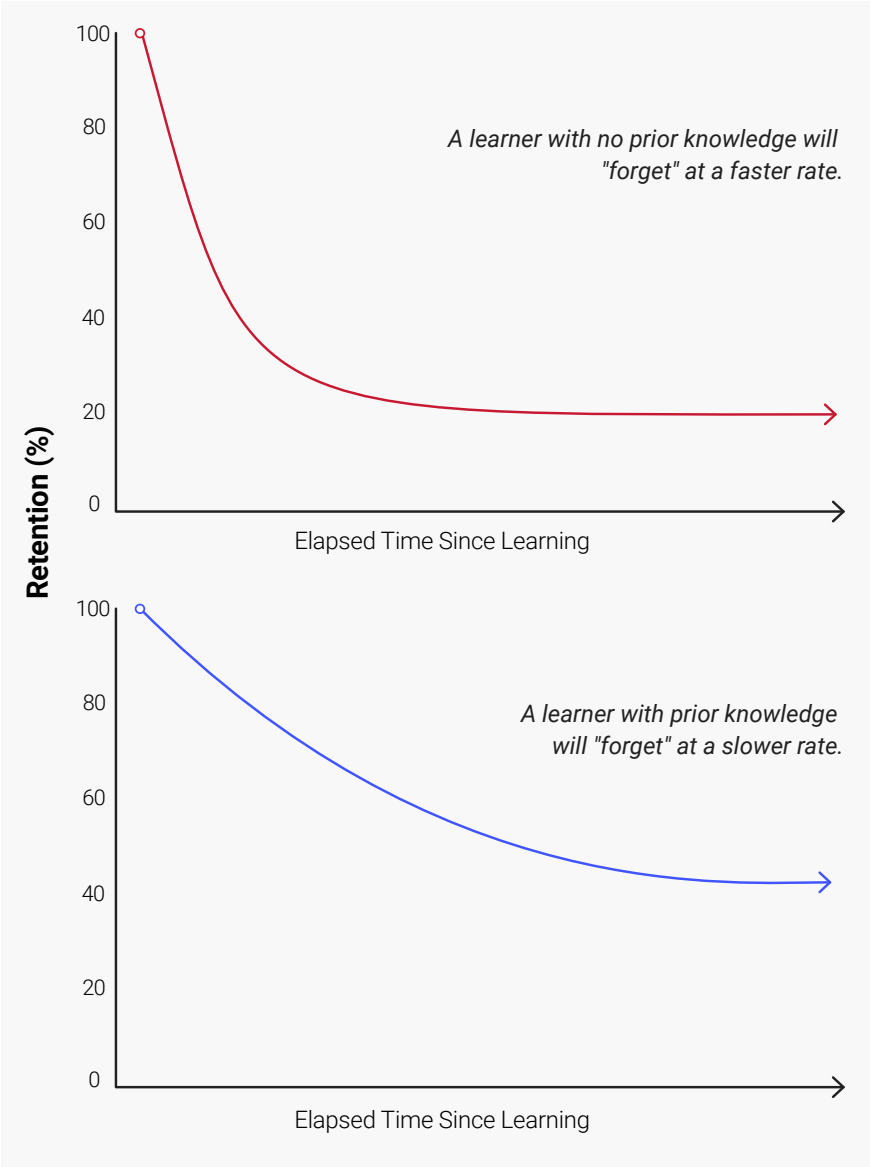
APPLIED FORGETTING

In the late 19th century, a German experimental psychologist named Hermann Ebbinghaus pioneered the scientific study of memory. **Ebbinghaus hypothesized that memory retention progressively declines over time in a rapid, exponential fashion.**

In his experiments, he studied the memorization of nonsense syllables, such as “ZOF” and “WID,” by repeatedly testing himself after various time durations. His **exponential decay curve is not a true representation of workplace learning,**[3] where learners’ retention will be strongly influenced by their prior knowledge.

Instead of using a simplistic decay curve, OttoLearn dynamically calculates a **unique forgetting signature** for every learner for every Concept, based on their Strength of Learning (SOL) for that Concept. This signature is then used to decrement the learner’s Mastery Level over time, simulating their true forgetting curve.

Learners who demonstrate greater proficiency on a Concept will “forget” more slowly than learners who take longer to demonstrate proficiency.



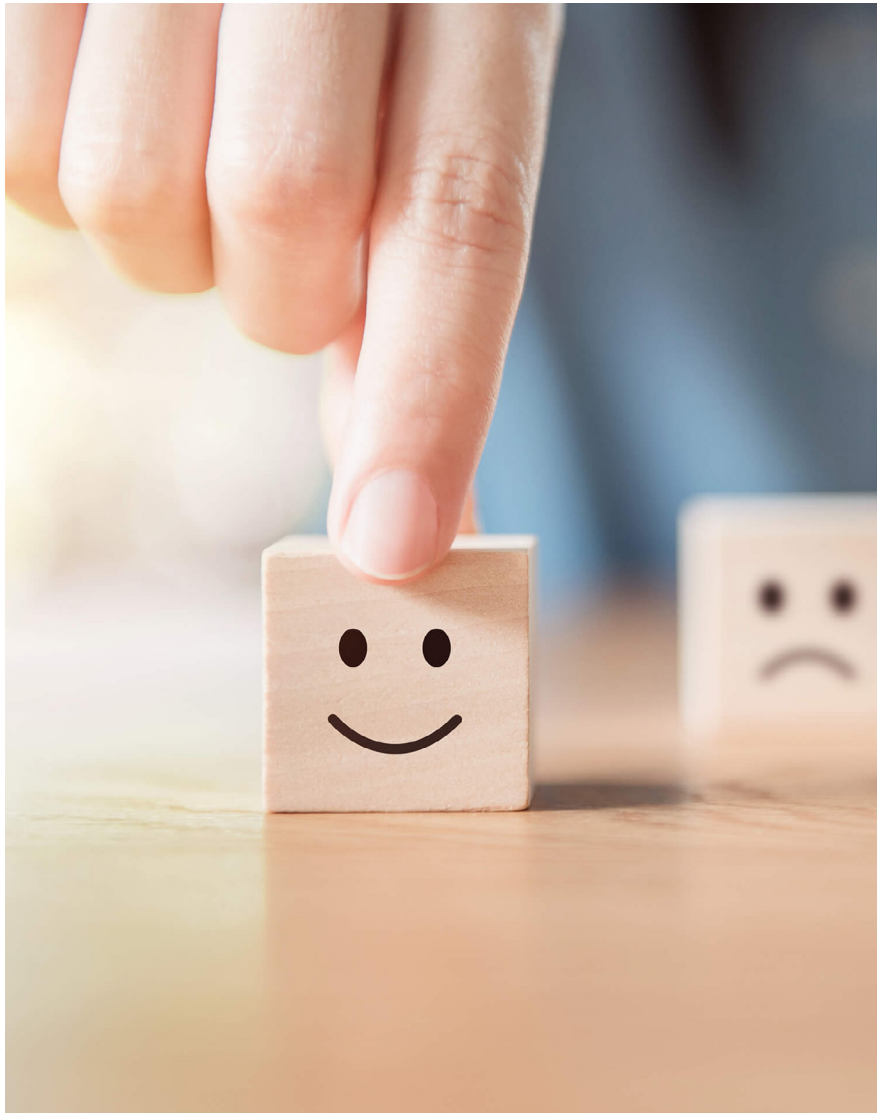
[3] *https://www.worklearning.com/wp-content/uploads/2017/10/How-much-do-people-forget-v12-14-2010.pdf*

FORMATIVE FEEDBACK

The timing, structure, and content of post-assessment feedback has a strong influence on learning and retention.

Researchers Bangert-Drowns et al[4] describe five states of learner feedback.

States	Description
Initial state	OttoLearn assumes that the learner begins with no prior knowledge.
Search and retrieval strategies	OttoLearn measures the learner's retrieval time, as well as other factors, to form a model of proficiency.
Response	OttoLearn requires learners to self-assess their confidence in a selection in order to receive the result.
Evaluate result	OttoLearn presents specific feedback for each possible response scenario.
Adjustments	OttoLearn automatically adjusts the learner's Mastery Level for a Concept after each performance; this determines which Activities are presented to the learner in future sessions.



[4] *Bangert-Drowns et al. (1991, p. 217)*

FORMATIVE FEEDBACK

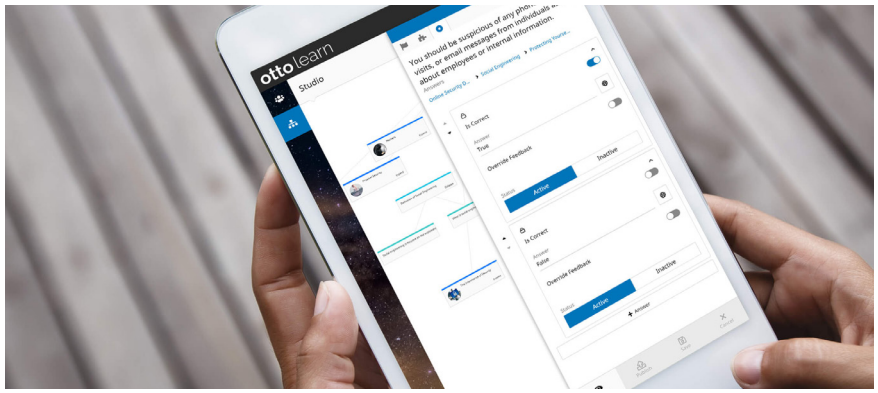
According to multiple studies, the content and the delivery of feedback are factors that help promote deep encoding and retention.

Prescription	OttoLearn's Implementation
Use praise sparingly, if at all[5]	OttoLearn provides objective feedback to the learner, without "loud" correct/ incorrect messages, which would focus the learner on self.
Provide elaborated feedback to enhance learning[6]	OttoLearn allows the trainer to provide custom feedback to the learner for each answer option, allowing for highly targeted feedback.
Present elaborated feedback in manageable units[7]	OttoLearn provides specific feedback on a per-Activity basis, enabling the learner to focus on the feedback prior to proceeding.
Provide immediate feedback to learners with little prior knowledge[8]	OttoLearn provides immediate feedback specific to each Activity.

WHEN LEARNING MATTERS

It's a great time to be involved in online training. We are slowly recovering from the impact of standardized training modules and moving back to adaptive training focused on efficient, long-term knowledge retention to the benefit of both the organization and the learner.

> OttoLearn has been designed from the ground up to leverage multiple proven learning theories to be **the most effective and efficient training tool possible.**



[5] *Kluger & DeNisi (1996), Butler (1987)*

[6] *Bangert-Drowns et al., 1991; Gilman, 1969; Mason & Bruning, 2001; Narciss & Huth, 2004; Shute, 2006),*

[7] *Mayer & Moreno, 2002; Phye & Bender, 1989*

[8] *Anderson et al., 2001; Azevedo & Bernard, 1995; Corbett & Anderson, 1989, 2001; Dihoff et al., 2003; Phye & Andre, 1989*

APPENDIX

The studies and experts referenced throughout this white paper can help you explore these areas of cognitive science more deeply. In addition, these Wikipedia links can serve as a starting point for further research into any of these areas:

- Gamification of learning[9]
- Deep encoding[10]
- Instructional scaffolding[11]
- The spacing effect[12]
- Adaptive training[13]
- The testing effect[14]
- The interleaving effect[15]
- Applied forgetting[16]
- Formative feedback[17]

[9] *https://en.wikipedia.org/wiki/Gamification_of_learning*

[10] *https://en.wikipedia.org/wiki/Elaborative_encoding*

[11] *https://en.wikipedia.org/wiki/Instructional_scaffolding*

[12] *https://en.wikipedia.org/wiki/Spacing_effect*

[13] *https://en.wikipedia.org/wiki/Adaptive_learning*

[14] *https://en.wikipedia.org/wiki/Testing_effect*

[15] *https://www.scientificamerican.com/article/the-interleaving-effect-mixing-it-up-boosts-learning/*

[15] *https://en.wikipedia.org/wiki/Forgetting_curve*

[17] *https://www.ets.org/Media/Research/pdf/RR-07-11.pdf*