Science of Learning Concepts

Classroom Teacher Pedagogy Standards EC–12 Learning Series

Introduction

The Science of Learning

The "Science of Learning" escapes easy definition. A scoping review by Privitera, Ng, & Chen in 2023 found that, across 50 different studies, researchers used 43 different definitions to describe the term.

The authors of the same review then added a 44th definition to the mix, defining the science of learning as **the "scientific study of the underlying bases of learning with the goal of describing, understanding, or improving learning across developmental stages and diverse contexts."** For the purposes of this paper, this definition is serviceable.

But even more important than the nuance of how we define the science of learning is the practical application of its concepts. These ideas and relevant research base must intentionally inform how *Bluebonnet Learning* instructional materials are designed and how we train teachers to deliver the content in those materials with fidelity.

In the following pages, I'll define and discuss key concepts from the body of knowledge generally known as "The Science of Learning" and connect them to the development of the K-5 Integrated product.

This paper is not exhaustive or comprehensive. Instead, it's focused on the highest impact practices that 1) align with human cognitive architecture, 2) maximize efficiency in instructional time and 3) will require careful engineering across both time and content areas to maximize the instructional effectiveness of the K-5 Integrated product.

Structure

Each section will follow the same structure:

1. Explanation
2. Design considerations for K-5 Integrated
3. References and resources

References and Resources

Defining the Science of Learning: A Scoping Review (Privitera, Ng, & Chen, 2023)

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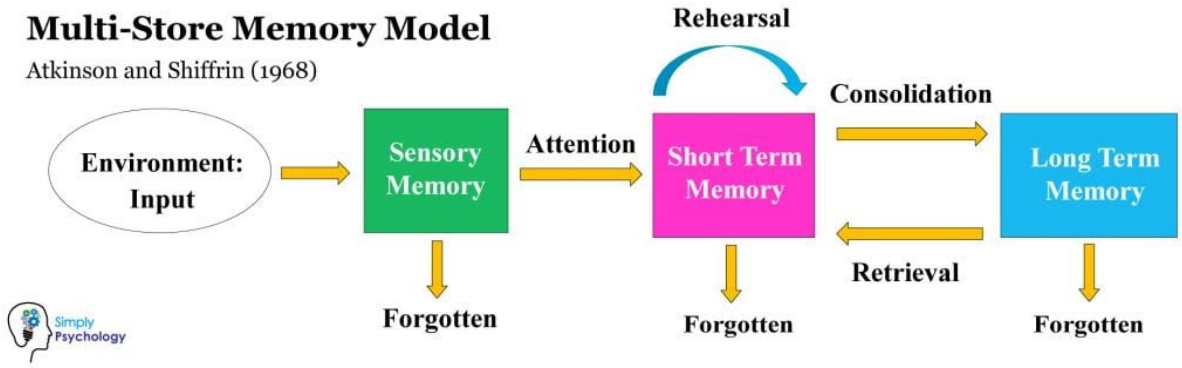
Models of Memory

Multi-Store Model of Memory

In 1968, Atkinson and Shiffrin proposed a "multi-store" model of memory. This model, which has been enhanced with additional detail over the last 50 years, is a helpful way to think about how memory works. It also sets the foundation for other concepts to be discussed later.



In the multi-store model, there are three main "stores": **sensory memory**, **short-term memory**, and **long-term memory**. Each store has its own characteristics related to **encoding** (how information is changed for storage), **capacity** (how much information can be stored) and **duration** (how long information can last in the memory store).

Sensory memory constantly receives information via the senses, but we don't pay attention to most of it, so it's quickly lost.

Short-term memory (STM) has a slightly longer duration (between 0-30 seconds), with a capacity of somewhere between 4-7 "chunks" of information. Information can be maintained in STM through maintenance rehearsal. An example of **maintenance rehearsal** is repeating a phone number to yourself so you remember it long enough to make a phone call. If maintenance rehearsal doesn't happen, the information is forgotten.

Long-term memory (LTM) has essentially unlimited capacity, and information can be brough from LTM back to STM as needed.

The concepts discussed throughout this paper focus on strengthening a learner's ability to retrieve information from long-term memory and combine it with new information in working memory.

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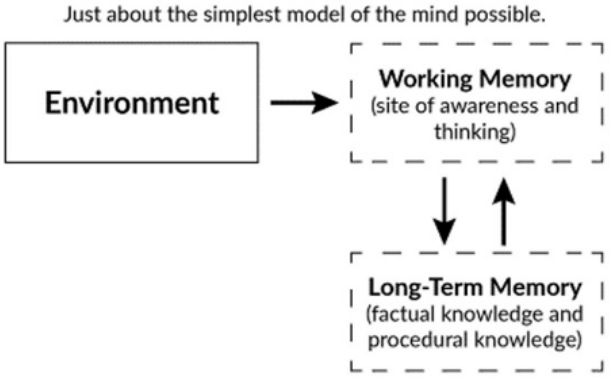
Willingham's Simple Model of the Mind

Daniel Willingham's (2009) simple model of memory is another useful representation for thinking about how students learn.



Like Atkinson and Shiffrin, information that students pay attention to from the environment enters **working memory (WM)**, which is where awareness and thinking happen.

The information in working memory is combined with information stored in **long-term memory (LTM)** to solve problems, answer questions, create new ideas, perform tasks, etc. The information in long-term memory can be factual or procedural, and, because of the relationship between WM and LTM, information that has been stored in LTM can be recalled in "chunks," which allows more information to be manipulated in WM in spite of its limited capacity.

Design Considerations

Even though no two students are alike, their cognitive architecture is generally the same. We can be confident that there is a set of principles based on human cognitive architecture that can improve the effectiveness of the design of the K-5 Integrated materials.

References and Resources

Human Memory: A Proposed System and Its Control Processes (Atkinson and Shiffrin, 1968)

Why Don't Students Like School? Because the Mind is Not Designed for Thinking (Willingham, 2009)

Why Don't Students Like School? (2nd Edition) (Willingham, 2021)