Using Learning Science Strategies to Enhance Teaching Practices and Empower Adult Learners

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Abstract: By leveraging research-backed strategies from the learning sciences, adult educators can help learners develop effective study habits that lead to deeper learning. This paper will discuss the harm in perpetuating neuromyths and how doing so can lead to negative outcomes for learners. Then, six strategies will be shared to help adult educators build and implement evidence-backed research practices in their classrooms. The strategies should lead to better study habits, more knowledge retention, and quicker retrieval speeds. Additionally, employing these techniques can lead to adult learners' building self-efficacy and confidence, which are essential to learner success.

Keywords: knowledge retention; learning sciences; learning strategies; memory; neuromyths

Research insights from the learning sciences — a catchall name for disciplines investigating the neurological processes of learning (e.g., cognitive psychology; neuroscience) — should be used to inform teaching and learning design. Cognitive scientists have conducted myriad empirical studies into memory and learning, lending insights into how learning happens. These evidence-based insights into how learners transfer and retain knowledge should inform teaching practices. Nevertheless, a long-standing disconnect between educational research and practice remains, perpetuating beliefs and practices with little to no evidence of their effectiveness.

Educators can plan for student learning using six strategies from the learning sciences (Sumeracki, 2019). These strategies are 1) retrieval practice, 2) interleaving, 3) spaced practice, 4) elaboration, 5) dual coding, and 6) using concrete examples. By employing teaching strategies and designing learning experiences that incorporate these techniques, adult educators can demonstrate research-backed study methods for their classrooms. Using these techniques is more likely to result in effective learning. Further, the practices should allow for quicker information retrieval, which, in turn, can enable learners to gain confidence in their learning capacity and capabilities.

The purpose of this paper is to discuss how and why adult educators can utilize these six study strategies. Following a brief introduction of past and current theories of learning and the brain, we will explain the danger of neuromyths and argue to support the need for evidence-based strategies in adult learning. Afterward, we will provide an overview of the suggested strategies and ways to apply them in practice. The paper will conclude with a discussion of how employing learning science strategies can empower adult learners.

Background

Research suggests even though information on the internet is readily available, cognitive processes, such as memorization and retrieval, are essential skills educators should help learners develop and practice (Fusco et al., 2020; Immordino-Yang, 2016). Helping learners master effective strategies for studying and employing techniques supported by cognitive science research can lead to greater knowledge retention.

How learning scientists conceptualize memory and neurological processing has developed over time. In the late 1800s, Ebbinghaus first theorized learning was created by "building associations among elements" (Roedinger & Yamashiro, 2019, p. 168). Nearly a century later, the metaphor of the mind as a computer entered the field — exemplified by Shiffrin and Atkinson's "three-box model" (Miller, 2022, p. 57), with the three boxes being sensory, short-term, and long-term memory. Short- and long-term memory are no longer viewed as separate processes (Richardson, 2007), and studies show information is received and transferred from working memory to long-term memory through various distinct subsystems. Additionally, long-term memory has various parts (e.g., semantic, episodic, and procedural) instead of a single box (Miller, 2022).

Although experimentation on the processes of learning and knowledge transfer continues, "[c]ontemporary theories do continue to portray memory as involving three distinct core processes: encoding, storage, and retrieval" (Miller, 2022, p. 83). Furthermore, Craik and Lockhart (1972)'s model of processing levels, from shallow to deep, is also generally accepted in the field. Experiments testing Craik and Lockhart (1972)'s theory show deeper processing correlates to stronger connection in long-term memory and quicker retrieval (McLeod, 2007). The learning and knowledge transfer process is more complicated than this review addresses; however, understanding fundamental theories of memory, information retrieval, and learning helps relate to techniques recommended and discussed in the rest of this paper.

Neuromyths: What They Are and How They Are Harmful

Unless research advances are translated and disseminated to inform practitioners, ongoing work in the field can become ineffective and, at worst, harmful. Neuromyths — misconceptions of how learning and teaching work — are created when brain research is misunderstood or misinterpreted and subsequently applied to teaching and learning.

Torrijos-Muelas, González-Víllora, and Bodoque-Osma's, (2021) systematic review of the "neuroeducation" (p. 1) literature reveals the most prevalent neuromyth is learners learn best via their preferred learning style. Despite evidence to the contrary, many instructors and teacher-trainer programs continue the practice of accommodating various learning styles. Learners' preference for a specific learning modality does not mean they will retain information or later access it from long-term memory.

Not only do neuromyths lead educators to utilize ineffective strategies, but they can also negatively affect student outcomes. For instance, if a student thinks they are an auditory learner, they may get easily frustrated and quickly give up reading a difficult text, believing their struggle is caused by their not being a visual learner. The problem lies not in the modality through which learners receive information, but in the fact that learners need to employ effective study strategies, such as note-taking and retrieval practice. For learners to transfer knowledge and

retain course content, they need to use study strategies that lead to quicker retrieval and stronger mental connections. Teacher training and professional development programs should emphasize evidence-based practices instead of putting time and resources into unproven methods.

Strategies from The Learning Scientists

The Learning Scientists (https://www.learningscientists.org/) identified six strategies for knowledge development backed by cognitive science research. We will discuss each strategy and its relation to the neurological processes of learning. Table 1 shows how adult educators can apply various learning techniques.

Table 1.
Ways for Adult Educators to Apply Learning Strategies

Learning Strategy	Explanation	Example Applications
Retrieval practice	Quizzing learners on content to assist with memorization and quicker access to stored information	Demonstrate how to study vocabulary by providing several different types of exercises (e.g., matching, crossword puzzles, fill-in-the-blank sentences)
Interleaving	Studying multiple topics instead of "chunking" learning in sequence	Organize several lessons around a common theme and jump from topic to topic; help learners organize a study schedule for several classes over time
Spaced practice	Studying topics multiple times and over an extended period; revisiting topics over many lessons	Designate a student notetaker for each class and then have them quiz learners on the topics in a later lesson
Elaboration	Discussing the how or why of topics to gain a deeper understanding	Have learners share examples of how they can apply a concept to their daily life (e.g., how photosynthesis is like getting energy after eating breakfast)
Dual coding	Using words and visual representations to learn and study a topic	Get learners to draw out their understanding of a concept or process, then explain it to a partner in their own words
Concrete examples	Relating abstract topics to real-world experiences of learners	Ask learners to find examples to pretend to explain a topic to a kindergartener or their grandmother

Discussion

Retrieval Practice

In short, retrieval practice facilitates memorizing information. Educators tend to focus more on higher-level thinking skills and, in doing so, fail to facilitate learners' mastery of foundational knowledge. Learners need clear understanding of a topic before they explore it more deeply. In *Make it Stick: The Science of Successful Learning*, Brown, et al (2014) explained how retrieval practice builds strong neural pathways: "[R]ecalling what you have learned causes your brain to reconsolidate the memory, which strengthens its connections to what you already know and makes it easier for you to recall in the future" (p. 20). Showing learners how to study using retrieval practice promotes curiosity that may facilitate higher-level thinking and better problem-solving. Once learners have a firm understanding of the basics, they struggle less with recall and, thus, have the mental energy to explore ideas and concepts more deeply.

Interleaving

Studying several topics at once is known as interleaving or varied practice. In contrast, learners who use a blocking technique led to less knowledge transfer, especially over time. Blocking is when learners study a single topic in its entirety over a "block" of time before shifting focus to another topic (Fröhlich & Rogers, 2022). Meta-analysis (Firth, Rivers, & Boyle, 2021) of 26 interleaving studies provided evidence for the benefits of interleaving as a study strategy for new and previously studied information. Interleaving "aids in the ability to *discriminate* related concepts and that awareness of those discriminating features contributes to a richer understanding of what is being learned" (Fröhlich & Rogers, 2022, p. 263). Despite evidence of interleaving's effectiveness as a study strategy, learners often dislike and avoid this study technique because it takes longer to implement, and learning happens more slowly. Such resistance could be one reason most interleaving research occurs in laboratories instead of classroom environments (Firth et al., 2021).

Spaced Practice

When learners study material repeatedly over time, they use the technique known as spaced practice. Spaced practice leads to long-lasting effects on long-term memory through a process known as consolidation. Brown et al. (2014) explained repetitive information retrieval, with intermittent breaks to allow time for consolidation to occur, strengthens "memory traces (the brain's representations of … new learning)" (p. 49). Fröhlich and Rogers (2022) further detailed that learners will continue to process and consolidate learning gains even when they are not actively paying attention or thinking about what they have just learned!

Elaboration

Kirschner and Hendrick (2020) attributed Charles Reigeluth (1979) as the developer of elaboration theory, whereby learning a new concept occurs by comparing it with a known concept using an analogy or some other type of connection between the two. Fröhlich and Rogers (2022) specified elaboration works only when the new concept is "connected to pre-existing knowledge" (p. 267) because elaboration has learners connect new knowledge to old; when old knowledge is retrieved, the new knowledge "sticks." Elaboration as a learning strategy should work well with adult learners, especially if instructors can get learners to relate novel topics to their lived experiences and, by extension, their prior knowledge.

Dual Coding

Dual coding refers to the technique in which learning occurs through both verbal and visual representations. While this strategy may seem like another way of saying "learning styles," the difference is dual coding requires learners to study and learn content for both representations (Sumeracki, 2019). Clark and Paivio's (1991) dual coding theory "consists of hypothetical networks of verbal and nonverbal representations and descriptions of the mediating patterns of activation (i.e., states of the network) that intervene between stimulus and response events" (p. 157). In other words, learners can connect and form associations between verbal and visual systems to learn more deeply (Kirschner & Hendrick, 2020).

Concrete Examples

In the strategy known as *concrete examples*, learners are instructed to relate applied uses or real-world examples to new course material. This study technique works particularly well with learning abstract concepts. "Learning is stronger when it matters, when the abstract is made concrete and personal" (Brown et al., 2014, p. 11). Adult student populations should expect their instructors to relate classroom content to their lived experiences, which is one of the first four assumptions Knowles (1980) proposed to distinguish andragogy from pedagogy.

The six presented study techniques particularly benefit adult learners because the strategies incorporate many foundational qualities attributed to andragogy, such as including reflections and real-world experiences in course content and having students take ownership of their learning. One way in which adult educators help their students own their learning is by explaining how learning happens. Providing information and instruction on metacognitive and research-backed techniques, like interleaving, will help learners build effective study habits beyond any single classroom.

Educators should also design learning experiences with research-backed study strategies built into them. For example, spaced practice is implemented by repeating material presented differently across several lessons. Including both verbal and visual content representations could benefit student learning by modeling the dual coding learning technique. Additionally, repeated retrieval practice will help learners form strong connections in their foundational knowledge. Learners can access prior knowledge more quickly and effectively when they form indelible mental connections. Easier recall allows learners to have confidence in their understanding (Cogliano et al., 2019, p. 127), which should result in the learners feeling less stress and having more time to explore topics in depth. Lower anxiety levels can promote curiosity for learning, which, in turn, can result in higher levels of engagement that may lead to an endless cycle of discovery and learning. Adult educators need to abandon neuromyths and teach more than disciplinary content knowledge. Learner empowerment can occur when instructors teach how to study and learn, explain how study strategies lead to learning gains, and model how to sustain curiosity for learning.

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