Coverage of Effective Learning Strategies from Cognitive Psychology in EFL Teacher-Training Textbooks

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EFL 教育研修用テキストにおける認知心理学に基づく効果的な学習ストラテジーの網羅性

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ABSTRACT

Cognitive science has identified numerous learning strategies that have been empirically shown to be effective at improving retention and facilitating the future retrieval of things studied. Although much of this knowledge is not new, it has yet to be effectively communicated to K-12 teachers (Pomerance et al, 2016). Of the various effective learning styles that have been identified, six have been recognized as being particularly beneficial. Thirteen teaching English as a Foreign Language (EFL) texts were assessed to determine the coverage of the effective strategies along three parameters: the degree of conceptual information, the level of prescriptive suggestions, and the number of references to relevant research in the literature. The data reveal that the texts used to train EFL teachers have not kept pace with the contemporary research that exists within the learning sciences and that there is a real need for improvements to be made.

Keywords: learning strategies, teacher development, EFL teacher-training textbook analysis

1. Introduction

The primary task for a teacher is to promote learning in their students. Methods to increase teachers' ability to effectively and efficiently increase student knowledge and ability should be essential to any teacher training program. Although this statement seems obvious, it does lead to two questions:

1. What are the most effective and efficient ways to learn?
2. To what degree are would-be teachers educated in what has been proven to be effective teaching practice?

1.1 Effective ways to learn

Fortunately, much is known about the first of these two questions. For close to half a century the field of cognitive psychology has produced research-verified cognitive learning strategies that provide answers (Dunlosky, Rawson, Marsh, Nathan, & Willingham, 2013) (Metcalfe & Kornell, 2007). Of the various learning strategies that have been studied, six have been recognized as being particularly effective (Weinstein, et al, 2018). These are:

1. Spacing
2. Retrieval Practice
3. Interleaving
4. Elaboration

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5. Concrete Examples
6. Dual Coding

Following is a primer on six learning / teaching strategies that have been shown to benefit learning. Although all six accrue benefits upon the learner, the first three (i.e., spacing, retrieval practice, and interleaving) focus on the temporal planning of study and the reinforcement of learning. The latter three (i.e., elaboration, concrete examples, and dual coding) help with improving understanding and knowledge transfer.

Spaced practice, sometimes referred to as distributed practice, has been studied for a long time. Ebbinghaus (1885/1913) demonstrated empirically how he could improve the efficiency of his learning through the use of distributed study sessions. In only thirty-eight study cycles, he attained an equivalent level of learning usually achieved in sixty-eight study cycles by spacing the study sessions across three days as instead of completing the study in one massed session (Roediger, 1985). Since that time, hundreds of studies, both inside and outside the classroom, have demonstrated the power of spaced practice.

Studying a given amount of material for a single period of time is known as massed study (See Figure 1). For example, a single sixty-minute study session of an amount of material without non-studying intervals (known as lags). Now, if the same amount of material was studied over multiple sessions and intervals (lags) between each study session exist, this would be spaced practice (Weinstein et al, 2018). The duration of the interval between the study and if they should occur at regular intervals or with increasingly longer lag times is still under investigation (Dunlosky & Rawson, 2015). It is generally accepted that longer lag times (e.g., greater than one month) lead to better retention (Cepeda, Pashler, Vul, Wixted, & Rohrer, 2006).

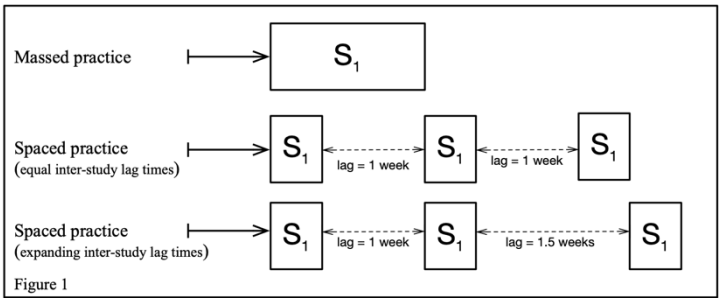

Figure1. Massed Practice and Spaced Practice with Various Lag Times. Shows the various study options available to the teacher / student. Note that the content of each study season does not change (S_1)

"Learning is not just about passively taking in information, but is a process that involves receiving input, encoding it as a memory, and then actively reconstructing that memory through retrieval," according to Karpicke et al (2011, p.772). The process of retrieval, which is also known as the testing effect, has been shown to improve learning outcomes across a variety of subjects, including general knowledge, foreign language pairs, and science, and has been effective with learners of all ages. Retrieval practice is using output to improve learning. Despite being sometimes referred to as the testing effect, the purpose for including it is not for summative assessment. Instead, it is a learning activity. A normal pattern may be beginning with a study session and then following the study phase, retrieval is used in a variety of ways. This series of retrieval opportunities may culminate in a summative test as would be the norm in a study/ re-study classroom pattern (See Figure 2). Retrieval practice can take many forms. These could be simple activities such as asking students to write down everything they know about a subject (known as a Brain Dump) to more complex quiz-type activities that require more preparation from the teacher. The benefits of retrieval practice are many. Two direct benefits are improved consolidation and retention of memories. Indirect benefits also exist, including that retrieval identifies the learner's gaps in knowledge, which provides feedback to the teacher and improves that learner's metacognitive judgement of their own learning. The highlighting of gaps in knowledge also prepares

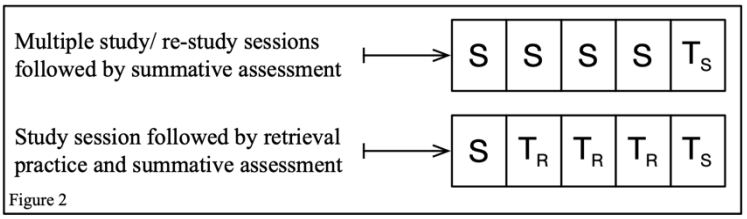

Figure 2. Consecutive study sessions end with a summative test contrasted with a study session followed by retrieval sessions and ending with a summative test

students to learn more from subsequent study sessions as they notice the 'answers' to what they had not been able to retrieve. Regular retrieval practice can also lead students to adjust their study habits to actively produce knowledge rather than just passively re-experiencing it. Finally, retrieval practice has been shown to enhance motivation and engagement, leading to more effective learning (Roediger, Putnam, and Smith, 2011). Karpicke et al. (2011, p.772) wrote, "Not only does retrieval produce learning, but a retrieval event may actually represent a more powerful learning activity than an encoding event."

Interleaving is the 'inter-spacing' of learning episodes so that some new knowledge (Thing A) is alternated with related but different knowledge (Thing B) (See Figure 3). To maximally benefit learning via this strategy the differences between Thing A and Thing B should not be too obvious. One way that interleaving benefits learning is by improving discriminability (Rohrer & Pashler, 2010). This is the ability to identify the differences between two or more things. Additionally, once one can discern that Thing A is not the same as Thing B, then a strategy of what should be done next in a process could be correctly applied. The inability to make these distinctions can result in discrimination errors. In the domain of language learning, such errors may come in the form of minimal pair sounds (e.g., / b / versus / v / for some learners of English). A second way that interleaving can benefit learning is that it helps students to improve their category induction knowledge. This is when a variety of things are present and through interaction with different yet similar things side-by-side, it become possible to comprehend the differences. Bjork and Kornell (2008) reported on a study in which students had to learn to identify the styles of various artists. In one group, the artists' work was presented in block formation. In a different group, the paintings were presented in an interleaved manner. On the final test, subjects saw paintings that they had not yet seen and had to identify the artist. The blocked group scored 36% whereas the interleaved group scored 59% (Bjork and Kornell, 2008).

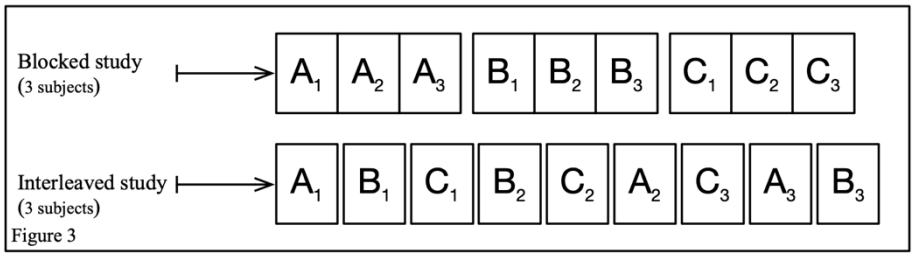

Figure 3. Blocked study versus interleaved study, where the order of study topics is inter-spaced.

There are several theories that attempt to explain the mnemonic benefits of spaced practice, retrieval practice, and some aspect of interleaving. These include the deficit processing theory (Hintzman, Block, & Summers, 1973; Cepeda et al, 2006), encoding variability theory (Glenberg, 1976; Cepeda et al, 2006), consolidation theory (Wickelgren, 1972; Pavik & Anderson, 2003; Cepeda et al, 2006), study-phase retrieval theory (Thios & D'Agostino, 1976; Cepeda et al, 2006), and the new theory of disuse (Bjork & Bjork, 1992; Bjork, 2012). The last of these theories, the new theory of disuse, accounts for many aspects of learning and the fragility of recall of some types of learned material, and I will provide a more detailed overview of the theory below.

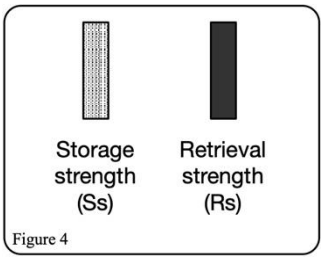

Figure 4. Storage strength (grey) and retrieval strength (black)

While the desire to speed up learning is understandable, it can be counterproductive if it sacrifices real retention of new information. Instead, tasks like spaced repetition, interleaving, and retrieval practice, which require effort when trying to recall previously studied material, are more effective at promoting long-term learning. These "desirable difficulties" (Bjork, 2012; Bjork & Bjork, 1992) may not be pleasant, but they are effective, and they result in positive outcomes. According to Bjork's new theory of disuse, each memory has both a retrieval strength, or the ease of accessibility of the memory, and a storage strength, or the degree to which it is being consolidated in long-term memory (See Figure 4). There is a relationship between the storage strength and retrieval strength of a memory. When studying or practicing, both the storage strength and retrieval strength of a memory

can increase, but the greater the retrieval strength during study, the less the storage strength will increase. Bjork explained this dynamic by saying, "When something is very, very accessible right now, virtually no learning can happen" (2012). This relationship can be seen when comparing massed practice, or a single extended period of study on one subject, to spaced practice, or dividing study time into separate sessions. During massed practice (See Figure 5), the familiarity and retrieval strength of the study subject increase with time spent on task, but the rate of increase in storage strength decreases. In contrast, spaced practice allows for a greater increase in storage strength because the start of each session includes some retrieval practice if the lag time between sessions is long enough for the retrieval strength to fade (See Figure 6).

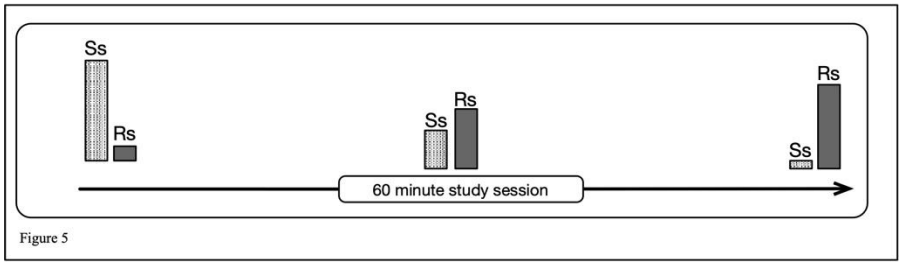

Figure 5. The reduction in storage strength as retrieval strength increases in a massed study session.

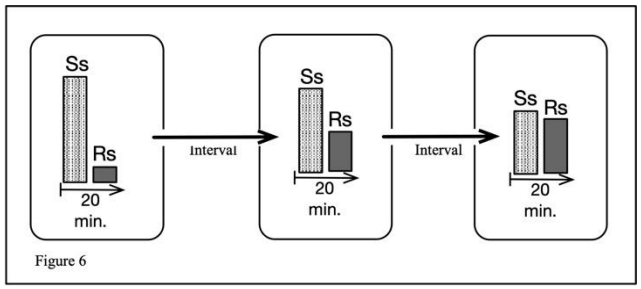

Figure 6. In spaced practice, the retrieval strength weakens following each lag allowing for an increase in storage strength (i.e., learning).

Hirschman (2001, p.4369) defined elaboration as “A conscious, intentional process that associates to-be-remembered information with other information in memory.” Considering this definition, it is possible to draw out three components that show how elaboration can be used as a learning strategy. The three parts are:

- That elaboration is conscious and intentional,
- That elaboration is about making associations,
- That the associations are with things currently in memory.

Some learning strategies can happen without the learner realizing that they are benefitting from the experience and increasing the level of transfer of learning that they are gaining. Retrieval practice would be an example of such a situation. This is not the case with elaboration. Elaboration is explicitly pointing out connections between one thing and other things and then identifying what makes them the same and what makes them different. This conscious attention to how things are related improves how new knowledge is integrated into the pre-existing knowledge structures (Weinstein, Maden, & Sumeracki, 2018).

Humans exist in an environment and this context adds to the context and associative memory traces that are encoded when something is learned. By associating new concepts with concrete examples (perceptual and/or motor experiences), teachers connect new knowledge with prior knowledge. This has been demonstrated at the word level (Caplan & Madan, 2016) and at the concept level (Goldstone & Son, 2005). However, if a concrete example is not broadened to become more abstract, then the student understanding of the final idea may not transfer beyond the limits of the specific concrete form. That is, if students only remember a variety of discrete concrete examples, then the new information will not be well integrated with pre-existing knowledge and there is an increased likelihood that it will be forgotten. One way to increase the success of transfer from concrete examples to abstract concepts is through a process known as concreteness fading (also known as progressive idealization). In this process, the details of a concrete example are progressively lost and elements common to a variety of examples are identified. Bruner (1966) suggested that new concepts and procedures should be presented in three forms: an enactive form (a physical, concrete model); an iconic form (a graphic or pictorial model), and finally a symbolic form (an abstract model of the concept). Goldstone and Son (2005) studied how effective this progression is for learning science concepts and found that subjects learned best when examples

progressed from concrete to abstract. The reverse, abstract to concrete, did not generate the same level of learning.

A lot of information is contained within a single picture. If one tried to accurately communicate the details contained in a picture via words, it would be both time consuming and quite challenging. This communicative efficiency is one reason that dual coding helps improve understanding and learning. When something is presented with words and pictures in conjunction, i.e., two modes of presentation and thus the name 'dual coding', learners can more readily understand the explanation than if it were given in words alone (Mayer, 2002). Dual coding is founded on the idea that human information processing processes visual/pictorial input and auditory/verbal input along separate channels (Paivio, 1986). This assumption is in line with Baddeley's (1992) theory of working memory. Paivio also explains that the effect of combining the two modes is additive. This resulting increase in neural network signal strength results in improved retention. When learners make connections between dual modes of information, they are also establishing connections between multiple brain regions. Although multimodal presentation of information can have a positive impact, if the added elements contain too many extraneous sounds, complex graphics, and entertaining but irrelevant content, the student attention may be diverted from the learning target and comprehension and encoding may be impeded.

1.2 How aware are teachers of effective learning strategies?

Teachers are busy and most do not have the time or energy to read academic studies (Roediger, 2013) that are buried in papers which may be hidden behind a paywall. What they have had access to is teacher training textbooks used in the course of their professional licensing programs. In an examination of popular teacher education textbooks (N=48) used in teacher training programs in the United States by Pomerance, Greenberg, and Walsh (2016), it was found that 59% made no mention of empirically verified effective learning strategies, and only 10% of the books included more than a page of explanation on any cognitive learning strategies. This is not enough to provide teachers with the skillset and knowledge that they need to ensure the success of their students. The Pomerance et al study looked at the American teacher-training context. A similar study by Surma, Vanhoyweghen, Camp, and Kirschner (2018) examined the coverage of two of these effective learning strategies (spaced practice and retrieval practice) in introductory teacher education textbooks (N=61) used in Flemish and Dutch teacher training programs. They found that 21% of the texts fully described spaced practice, but almost 66% made no mention of the strategies at all. The coverage was worse for retrieval practice which was not referred to in 84% of the textbooks. To effectively incorporate a teaching strategy into their teaching practice, would-be teachers need more than just a mention of a theory. In the Surma et al study, only 7% of the textbooks provided information on the concepts and how they could be used in the classroom. In a study of English as a Foreign Language (EFL) teachers in Japan, Lowes (2017) found similarly low numbers for teacher awareness of retrieval practice with 16.7% of teachers being aware of the concept but only 10% of teachers using it in their teaching practice. As with the Surma et al study, awareness of the concept of spaced practice was greater, at 33.3%, than it was with the retrieval practice.

The Pomerance et al (2016) study and the Surma et al (2018) study both examined the textbooks used in teacher training programs; however, a similar examination of EFL teacher training textbooks had not been carried out. Therefore, the following study sought to examine what effective learning strategies based upon the findings of the cognitive science of learning are contained within EFL teacher training textbooks.

2. Methods

2.1 Research Questions

This study had three research questions that it sought to gain some clarification on. These questions were:

1. To what degree, if at all, are the six cognitive learning strategies described in the EFL teacher training textbooks?
2. To what degree, if at all, are explanations of how to implement the six cognitive learning strategies in the classroom described in the EFL teacher training textbooks?

3. To what degree, if at all, are references to primary research on the six cognitive learning strategies mentioned in the EFL teacher training textbooks?

2.2 Hypotheses

Based upon other examinations of teacher training textbooks in other contexts within the literature (Pomerance et al, 2016; Surma et al, 2018), I suspected that comprehensive coverage of the six learning strategies identified by cognitive psychological research as particularly effective (Weinstein et al, 2018) would not exist. I defined comprehensive coverage in line with the Surma et al (2018) study in which the trifecta of conceptual explanation, prescriptive explanations, and references to further resources represented a comprehensive treatment of the learning strategy. Based upon the Lowes (2017) study, I felt that it was quite likely that there would be instances in which a study/learning strategy was described in practice, but that it would not be named according to the common names in cognitive psychology, nor would it have any references to further research in the literature.

2.3 The Research Tool

The rubric (see Appendix 1) used to assess the teacher training books was based upon that used in the Surma et al (2018) study. Permission was granted to adapt the rubric to suit the EFL context. In the Surma et al study, the teacher training textbooks were examined to assess their coverage of two learning strategies: spaced practice (distributed practice) and retrieval practice. In the current study, four additional learning strategies were included: interleaved study, concrete examples, elaboration, and dual coding.

The rubric assessed each learning strategy on three parameters: description and purpose of the strategy, guidelines for practical implementation in classrooms, and references to research. For each of these parameters, a numerical score was assigned of zero (no mention), one (a brief description of the strategy/how it can be implemented is mentioned), or two (a full description of the strategy and explicit theoretical/practical explanation are mentioned). In the parameter assessing the degree to which references to research are mentioned, a zero was given for no mention to research in the literature, a one was given for a single reference to an author or important study on that strategy, and a two was given if multiple authors and/or studies were referenced.

2.4 The EFL teacher training texts evaluated

English as a Foreign Language (EFL) training textbooks are an important component in any teacher training course. Many of the texts that support EFL teachers in their professional development are of the ‘recipe’ book variety, which aim to give teachers activity ideas or ways to practice some segment of a normal lesson. In this study, that style of text was not examined. Instead, this study looked at thirteen texts that sought to ground the practice of EFL teaching in a theoretical basis. Of course, these books often presented examples to illustrate a theory or an approach, but they did contain much more perspective than simple lists of things to do.

2.5 How the texts were analyzed

All texts were read and assessed using the scoring rubric. Notations were also made on non-strategy advice to teachers that is not in line with current understanding from the field of cognitive psychology. The results were tabulated. In instances when there were multiple mentions of or references to a strategy in one text, it was scored at the level of the best of the references of that parameter.

3 Results

The analysis of the coverage of effective learning strategies as identified by cognitive psychological research revealed that there was very little conceptual information, prescriptive information, and almost no citations given with the thirteen teaching English as a Foreign Language (EFL) teacher training texts reviewed (See Table 1).

Table 1. EFL teacher training texts that include learning strategies and their level of coverage (N=13).

	0=No coverage (%)	1=Partial coverage (%)	2=Full coverage (%)
Spaced practice			
Conceptual information	11 (85)	1 (8)	1 (8)
Prescriptive information	9 (69)	3 (23)	1 (8)
References to research	12 (92)	0 (0)	1 (8)
Retrieval practice			
Conceptual information	13 (100)	0 (0)	0 (0)
Prescriptive information	9 (69)	4 (31)	0 (0)
References to research	12 (92)	1 (8)	0 (0)
Interleaving			
Conceptual information	13 (100)	0 (0)	0 (0)
Prescriptive information	13 (100)	0 (0)	0 (0)
References to research	13 (100)	0 (0)	0 (0)
Elaboration			
Conceptual information	11 (85)	2 (0)	0 (0)
Prescriptive information	11 (85)	2 (0)	0 (0)
References to research	13 (100)	0 (0)	0 (0)
Concrete Examples			
Conceptual information	13 (100)	0 (0)	0 (0)
Prescriptive information	13 (100)	0 (0)	0 (0)
References to research	13 (100)	0 (0)	0 (0)
Dual coding			
Conceptual information	11 (85)	2 (15)	0 (0)
Prescriptive information	12 (92)	1 (8)	0 (0)
References to research	12 (92)	1 (8)	0 (0)

4 Discussion

4.1 Discussion of the Results

Overall, the analysis of the thirteen EFL teacher training textbooks revealed that there is very little coverage of the six effective learning strategies that have been identified by cognitive psychology researchers who study maximally effective methods for learning. Although the studies by Pomerance et al (2016) and Surma et al (2018) revealed that there was not much comprehensive coverage of these learning strategies within university teacher-training textbooks, the coverage within the EFL teacher-training materials was much lower. It is difficult to identify what the cause of something is; however, a hint may lie in something that was contained within many of the EFL teacher-training textbooks reviewed. This is a reliance on outdated psychological theories (e.g., right brain/ left brain personality differences) (Neilson et al, 2013) or even pseudoscience (e.g., neurolinguistic programming) (Austin, 2020) that is not fully grounded in scientific research. Because the authors of the EFL teacher-training textbooks were seemingly content that their ideas were based on science, they seemingly did not feel compelled to explore a different ‘silo’ of knowledge and explore the findings from cognitive psychology. This separation of those who espouse best practices in teaching from those who research the science of learning is an issue that should be addressed.

Being optimistic, I hope that with the passage of time, the authors of these texts will discover the scientifically grounded theories and incorporate them in future editions of their texts. There is certainly a need to increase the interdisciplinary cooperation between academics and textbook authors to provide the maximal benefit to all future students.

This study is a preliminary examination, and it did have some shortcomings. Firstly, only thirteen texts were evaluated. Although that number does not sound very large, it did represent just under five thousand pages of educational guidance. In future research, it would be better to double or triple the number of texts. A second weakness of this study was that some of the texts included in this study were not the most current books in the field. It would be wonderful to have access to the newest books, but there is also value in examining the state of the books used by many who are currently active in the profession of EFL teaching. Further research is needed to establish the best way that the field EFL can prepare would-be and in-service educators.

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Appendix 1. The rubric for assessing the comprehensiveness of the coverage of each strategy.

Category		Partial description	Full description
	No mention	A brief explanation of the strategy is mentioned. / A single example of implementing the strategy is included. (Example entries might be similar to what is below)	A comprehensive overview of the strategy is provided including explicit reasons why the strategy is beneficial. / A variety of approaches to implementing the strategy are described. (Example entries might be similar to what is below)
Spaced practice			
Description	No mention	• Distributing learning or practice over time improves retention	• The spacing effect results in improved learning. The periods between study sessions should be long enough to create a difficulty in recalling information (a desirable difficulty).

Prescriptive ideas	No mention	• Learned materials should be put aside or scheduled to be revisited at some point in the future.	• Use other types of desirably difficult tasks (retrieval practice or interleaving) in conjunction with the spaced practice. •
References	No mention	• One author/study mentioned	• Several authors/studies mentioned, and citations were provided.

Retrieval practice			
Description	No mention	• Testing increases learning	• Recalling information provides many direct and indirect benefits including improving consolidation, revealing what is known and not known to the learner and the teacher, it increases the likelihood that the information will be learned/noticed at future exposures.
Prescriptive ideas	No mention	• Using any activity that makes students produce previously learned information	• Active recall tasks such as ‘brain dumps’ of previously learned materials, using formative assessments and no-stakes quizzes
References	No mention	• One author/study mentioned	• Several authors/studies mentioned, and citations provided.

Interleaving			
Description	No mention	• The inter-spacing of different but similar study subject	• Improves the ability to discern between similar but different things, useful for improving the ability to not confuse things such as minimal pair sounds and similar mathematical procedures. If the two or more things studied are obviously different, the benefit will not accrue.
Prescriptive ideas	No mention	• Mix things to be studied so that any one thing is not taught in a block that is followed by a different block.	• Mixing things (e.g., A, B, and C) in a way that randomizes learner exposure to each topic. Ideally, two adjacent topics should be similar but different. Have an assortment of similar but different things (questions, tasks, etc.) and have the students develop categories based upon the similarities and differences that they notice.
References	No mention	• One author/study mentioned	• Several authors/studies mentioned, and citations provided.

Elaboration			
Description	No mention	• This is purposefully making mental associations with other concepts or things.	• Elaboration is the process of consciously making connections between new knowledge and things that are already within memory.
Prescriptive ideas	No mention	Draw mind maps to connect concepts visually.	• Use strategies such as elaborative questioning to explore the how and why of new concepts and thereby form more intricate and deeper understanding.

References	No mention	• One author/study mentioned	• Several authors/studies mentioned, and citations provided.

Concrete examples			
Description	No mention	• Connect new knowledge to prior knowledge that is part of the perceptual system or motor system.	• Related to the theory of embodied cognition, creating associations that are grounded in perception and action. Care should be taken to move away from concrete example and towards more abstract models using a process called concreteness fading.
Prescriptive ideas	No mention	• Experience new concepts through tactile exposure or descriptive imagining.	• Present new concepts in three forms. The first being the physical item or action, the second being a graphic or picture version of the concept, and the final mode being an abstract description/explanation.
References	No mention	• One author/study mentioned	• Several authors/studies mentioned, and citations provided.

Dual coding			
Description	No mention	• Both visual and verbal input can be processed at the same time without being overwhelmed.	• Although working memory is very limited, the underlying systems that process verbal input and visual input are not the same; therefore, it is possible to take in more information it is divided between the two modes. Care should be taken when choosing the visual media to avoid extraneous stimuli that may exist in video or real images.
Prescriptive ideas	No mention	• Provide simple visual input to accompany verbal instructions.	• Using multi-modal presentation that incorporates verbal and visual input such as shifting a concept from one mode to another. This could be combined with retrieval practice by having a learner recall previously learned material ina mode that is different to the mode that it was originally encountered.
References	No mention	• One author/study mentioned	• Several authors/studies mentioned, and citations provided.