

Science of Learning Strategy Series: Article 7, The Role of Context in Learning

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Abstract: The science of learning (learning science) is an interprofessional field that concerns itself with how the brain learns and remembers important information. Learning science has compiled a set of evidence-based strategies, such as distributed practice, retrieval practice, interleaving, and elaboration, which are quite relevant to continuing professional development (CPD). Spreading out study and practice separated by cognitive breaks (distributed practice), testing oneself to check mastery and memory of previously learned information (retrieval practice), mixing the learning of separate but associated information (interleaving), and making connections between concepts one is trying to learn and other known concepts (elaboration) represent strategies that are underused in CPD. Participants and planners alike can benefit from learning science recommendations to inform their decisions. Contextual learning, the subject of this article, is another evidence-based strategy that supports the study and practice of important information. By better understanding how the context in which one learns later affects retention and performance, CPD participants and planners can make more informed educational decisions.

Keywords: science of learning, learning science, continuing education, continuing professional development, context, contextual learning, context reinstatement, context-dependent memory effect, encoding specificity

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ABOUT THE SCIENCE OF LEARNING STRATEGY SERIES

Consistent with a 2019 *Journal of Continuing Education in the Health Professions*' editorial by Kitto about informing the continuing professional development (CPD) imagination,¹ the emerging and interdisciplinary field of the science of learning, which concerns itself with how the brain learns and remembers important information, is a compelling but relatively unfamiliar field that stands to inspire CPD participants and planners to think about educational interventions differently. Moreover, the science of learning (learning science) has compiled evidence in support of a set of strategies²⁻⁶ that can help CPD more effectively influence clinician knowledge, skills, attitudes, competence, and even performance. The purpose of the series is to bring attention to evidence-based, learning-science strategies, and to provide some background that might be helpful to CPD stakeholders considering the strategies and related information. The first three series' articles focused on the strategies of distributed practice, retrieval practice, and interleaving.⁷⁻⁹ In the fourth article, the authors demonstrated the application of these three strategies to

a common CPD activity, the educational meeting.¹⁰ In the fifth article, the authors addressed the importance of sleep to learning and memory in CPD.¹¹ In the sixth article, the authors described another learning strategy, elaboration.¹² In this seventh article, the authors introduce yet another strategy known as contextual learning.

THE ESSENCE OF CONTEXTUAL LEARNING

The essence of contextual learning, also known as “context reinstatement” and “context-dependent memory effect,”¹³ along with “encoding specificity,”¹⁴ is the idea that memory is better when memory cues that were available during encoding, the initial acquisition of the memory, are also available at retrieval, when memory is tested (see **Appendix, Supplemental Digital Content 1**, <http://links.lww.com/JCEHP/A330>). In other words, if a person learns something in a specific context, such as a classroom or clinical rotation, being able to reinstate that context can be helpful to accessing the memory at a later time. A context has many dimensions and features, such as environmental factors (eg, ambient noise)¹⁵ and personal states (eg, mood),¹⁶ or even different sensory modalities.¹⁷ However,

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the three contextual variables the authors believe are likely most actionable and effective are *how*, *where*, and *when* learners interact with priority information.

From this description, one could assume that the best way to improve learning and memory is to try to “match” the learning environment and the environment in which a person needs to remember. For example, a health professions student might think they should take their tests in the same classroom in which they learned the information. Taken even further, a student might think they should try to sit in the same exact seat within a classroom for each class period and for each test. Practically, this is not always possible, especially for practicing clinicians who are no longer taking traditional course-based tests but rather specialty and certification examinations. Furthermore, and more importantly, such consistency is not desirable. The purpose of health professions education is not to learn how to provide care within a single environment, but rather to learn and remember information so that it can be used in, or transferred to, different environments and situations. By learning and remembering information in a variety of settings, the resulting aggregate memory is more accessible across a broader range of settings. Thus, the authors argue that the value in understanding contextual learning is to appreciate how to decontextualize it (at least to some extent), such that what is learned is more likely to be remembered in various contexts in the future.

CLASSIC RESEARCH UNDERLYING CONTEXTUAL LEARNING

The classic experiment demonstrating context learning comes from Godden and Baddeley in 1975.¹⁸ In their experiment, the participants were members of a university diving club. The divers participated in the experiment in their diving gear and learned lists of words either on land (sitting by the edge of the water) or under water (diving to approximately 20 ft). Then, the participants recalled the words either on land or under water (Figure 1). They found that when the participants learned and recalled in the same context (land–land and water–water), they remembered significantly more than when they learned and recalled in the different context (land–water and water–land). When the contexts were the same, participants recalled 38% (land, land) and 32% (water, water) of the words. Whereas participants only recalled 24% (land, water) and 23% (water, land) of the words when the contexts differed. The

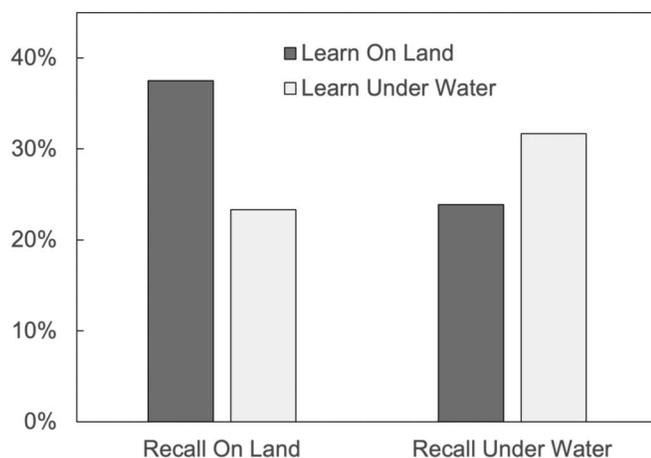


FIGURE 1. Illustration of percent of items recalled from Godden and Baddeley's¹⁸ diving club experiment 1 demonstrating context-dependent memory effects.

results demonstrate what cognitive psychologists call an encoding–retrieval interaction, where the pattern of memory retention changes, or even reverses, depending on the retrieval context.

There are many examples of experiments demonstrating encoding–retrieval interactions such as the one described above.¹³ One health care example involved first-year medical students wearing scrubs or their own clothing during a learning activity.¹⁹ The researchers conducted the experiment in authentic undergraduate medical courses during which students engaged with two lessons. The students first wore scrubs or their own clothing during a gross anatomy teaching session. Then, the students changed clothing so that the opposite clothing (their own clothing or the scrubs) was worn for a self-directed learning session focusing on kidney imaging. After each lesson, all students took a test to see how much they had learned. Five weeks later, the students took another retention test that covered content from both lessons, all in their own clothing. Thus, for some content, the retention test context was the same as learning (in their own clothes), while for other content, it was different (learned in scrubs but took the retention test in their own clothing). The authors reported a 10.1% average reduction in performance across the five weeks when the context did not match, but only a 4.2% average reduction when the context did match. In other words, learning in scrubs and testing in one's own clothing was associated with more forgetting than learning in one's own clothing to begin with.

One approach to applying these context effects could be to try to “match” the context as much as possible in the hopes of increasing the likelihood that context cues are available and lead to better memory during retrieval. However, this is not the approach the authors recommend for two reasons. First, the literature on context-dependent memory is complicated, and simply matching learning and retrieval contexts is not sufficient to improve memory.²⁰ Second, and more importantly, even if matching did always lead to improved memory performance, it still would not be practically possible to do. A much better application of these effects is to try to *avoid* reliance on the context. Instead, one should offer learning repetitions in as many different contexts as possible to reduce one's reliance on context cues, leading to more durable learning that can be remembered and used in many settings. Several studies have taken this approach and demonstrated the benefits of learning repetitions across different contexts.^{21,22} Using the previously described strategies in the series (ie, distributed practice, retrieval practice, interleaving, and elaboration) serves to make one less reliant on a specific context in which information was learned, making it more likely that one will be able to retrieve information in different contexts in the future.^{23–25}

NEUROSCIENCE UNDERPINNINGS OF CONTEXTUAL LEARNING

Memory recall typically benefits from contextual information as these were features of the original learning episode. However, as highlighted earlier, for learned information to be accessible in a variety of settings, it is ideal for information to become less contextually dependent, ie, decontextualized. As one might expect, it is difficult to study different learning contexts in a brain imaging study. Several studies have established that computer-based experiments that set different background scene images can function as distinct contexts.^{21,26,27}

Associations between distinct contexts and learning material have been shown to be reliant on connectivity between the

hippocampus, a key region involved in memory function, and the ventromedial prefrontal cortex (vmPFC).^{28–32} The vmPFC is a cortical brain region in the frontal lobe along the medial surface, ie, the surface that faces the other hemisphere. This region is slightly above the eye sockets. The vmPFC is associated with memory context and, more broadly, with situational monitoring (eg, memory schema, social norms, and risky decisions). Learning repetitions across different contexts weaken this hippocampal–vmPFC coupling for the learned information, making subsequent retrieval less limited by a context match.^{28–30} The weakening of these brain activity associations is desirable here because it means that the memory has become decontextualized, and as a result, accessing the memory across different contexts has become easier.

EXAMPLES OF CPD STUDIES INVOLVING CONTEXTUAL LEARNING

In one example of a CPD study involving contextual learning (in addition to distributed practice, retrieval practice, and interleaving) to measure knowledge and satisfaction with dermoscopy training for certified dermatologists and senior dermatology residents, Boespflug and colleagues³³ evaluated the addition of a spaced education e-learning module (daily emails with image-based multiple-choice questions following game mechanics; intervention group only) to an in-class training program (for both control and intervention groups) that included a 3-day lecture (46–50 participants), a 5-hour tutorial (10 participants), and a consultation (1:1) with a dermoscopy specialist. In support of learning dermoscopy skills to identify early-stage melanomas, the intervention group (and to some extent the control group) experienced variation in *how* they learned (large, small, and 1:1 training experiences plus online questions), *where* they learned (clinic, classroom, and home), and *when* they learned (work and/or after-hours for email questions). The combination of these variations produces contextual variability. As mentioned previously, the context also includes environmental factors and personal states, but here the focus is how, where, and when, as these are likely more actionable and effective.

As another example of contextual learning (in addition to distributed practice and interleaving), building on active and prior participation in simulation-based, national certification courses in pediatric resuscitation, Ojha and colleagues³⁴ designed and tested a spaced education critical care scenario management program to enhance retention of knowledge and skills among pediatric medical and nursing staff working in a teaching hospital. Every two weeks over a six-month period, the program shared clinical vignettes and expertly demonstrated responses to six scenarios (each repeated once) of pediatric emergencies as part of Pediatric Grand Rounds. Grand rounds' participants observed the experts and took part in the debriefing of the scenarios, which reflected certification knowledge, skills, and behaviors, such as the quality of the cardiopulmonary resuscitation. Relative to prior simulation learning, participants experienced a variation in how (observation and discussion), where (grand rounds), and when (spaced 15-minute biweekly sessions) they learned this information.

As a third example of contextual learning (in addition to distributed practice and interleaving), Zimmerman and Pilcher³⁵ describe a neonatal intensive care unit program designed to increase critical thinking skills among new and experienced nurses working in critical care. The program con-

verted primarily lecture-based approaches to more interactive ones. For example, for the unit's internship program, new nurses experienced a variety of methods, including case studies, skills laboratories, storytelling, clinical mentoring, and different exercises to develop important skills (eg, time management and care prioritization). For continuing education, experienced nurses participated in case studies added to lectures and in unfolding cases on unknown topics. In addition to changes in how nurses learned, they experienced learning in different places (where), such as through the unit's newsletter, and at different times (when), such as during mock codes.

RECOMMENDATIONS FOR CPD PARTICIPANTS AND PLANNERS

What can CPD Participants do to Leverage the Benefits of Contextual Learning?

For CPD *participants* considering educational options to make significant improvements in knowledge, skills, attitudes, and other important outcomes, selecting an educational activity that involves a mix of learning activities (eg, in-person observations and reflections, online questions, and unfolding case discussions) will provide a variety of cues tied to the process (the “how”) of learning. Participants can also make choices based on location (the “where”) of learning, taking advantage of opportunities to learn in the practice setting (eg, simulations and mock codes) and outside work (eg, active reading and writing at home), if they desire to remember and use what they are learning across different contexts in the future. Finally, participants can also make choices based on the timing (the “when”) of learning, such as before, during, and after work or on weekends. In this way, access to information is less tied to a particular time or set of times, such as at noon on Thursdays during grand rounds or on Sunday evenings while reading journals.

What can CPD Planners do to Leverage the Benefits of Contextual Learning?

Along with the content, CPD *planners* can enhance the educational value of activities by considering *how* participants might interact with information, *where* they might be learning, and *when* such activities might occur. For example, no longer restricting planning to lectures and readings will broaden how participants experience learning to involve many more contextual cues, such as those associated with a mixture of reading, writing, speaking, listening, and reflecting—what one biology-of-learning expert collectively refers to as “habits” of learning.³⁶ Unfolding cases, which can involve individual reflection and group discussion of key findings and decisions, involve more senses and brain regions than readings and lectures alone. Regarding where learning occurs, planners can leverage a technology to offer preactivities and postactivities that can occur inside and outside the workplace, broadening the cues associated with the place of learning. Finally, planners can consider synchronous and asynchronous options as part of educational activities, with such options typically involving variation of when learning occurs.

CONCLUSION

Contextual learning is a learning-science strategy that leverages the value of cues to remember important information. Despite specific cues being helpful in initially acquiring information, the

goal of contextual learning is to broaden the circumstances (ie, how, when, and where) of learning so that one's reliance on such cues is minimized if needed at all. By experiencing information in a variety of circumstances, one's access to information is broader than when access is tied to a limited set of cues. As such, cognitive science would advise CPD participants and planners alike to use as many learning science strategies (eg, distributed practice, retrieval practice, interleaving, and elaboration) as possible, as they will have the added benefit of reducing reliance on context. Neuroscience research demonstrates that learning experiences across different contexts weakens the coupling of key brain structures that would otherwise limit memory to contextual matches; thus, memory performance is less constrained by the context. Learning science can inform the imagination of CPD participants and planners alike, and contextual learning is yet another vehicle to enhance knowledge, skills, attitudes, competence, and performance.

Lessons for Practice

- Contextual learning is an evidence-based strategy that supports learning and memory through a variety of experiences that involve so many contextual cues that a specific set is less necessary or even unnecessary to recall priority information
- Contextual learning encourages CPD participants to vary how they interact with information, where they experience learning, and when they engage in learning so that many cues are associated with the information they seek to learn and to remember
- CPD planners can accomplish contextual learning by using the learning-science strategies of distributed practice, retrieval practice, interleaving, and elaboration, which typically result in a variety of contextual cues that promote mastery and memory

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