



TOP HAT

How Retrieval Practice Improves Learning:

The Impact of Frequent, Low-Stakes Assessments

Kevin Leung

Ph.D., Senior Learning Scientist



Over the past 30 years, the evolving science of learning has led to some well-established principles and evidence-based practices that can lead to better learning outcomes. For example, research has shown that learning with timely feedback, interweaved topics, spaced studying, and retrieval practice is more effective (e.g., Benjamin & Tullis, 2010; Clark & Mayer, 2011; Rohrer, 2012). These practices call for more **frequent low-stakes assessments**—which means low- or no-grade testing done as practice throughout students’ learning journey. Let’s take a look at what research says about these assessments and how they can be incorporated into a class.



Assessments are commonly used as tools to measure learning, but they can also be used to enhance learning. Instead of only asking students to apply information during high-stakes assessments (such as midterms or finals), instructors can have students apply it in low-stakes ways while they learn in class, read a textbook, or complete assignments at home. Research has consistently shown that frequent low-stakes assessments can improve students' retention and understanding of materials across many disciplines (e.g., Kapler et al., 2018; Karpicke & Blunt, 2011; Karpicke & Roediger, 2008; Roediger & Karpicke, 2006a; among many others). This approach enables **retrieval practice** for students, a strategy to strengthen memory by recalling information (Roediger & Karpicke, 2006b).

Research has shown that retrieval practice is more effective for learning than passively re-reading or mapping concepts (e.g., Roediger et al., 2011; Karpicke & Blunt, 2011; Roediger & Karpicke, 2006b). This is because the act of retrieving information can improve later recall even if mistakes are made along the way. When students answer questions correctly, continued testing on those items leads to better test performance than just repeatedly studying them (Karpicke & Roediger, 2008). Studies have

also shown that practice testing not only improves memorization but also understanding of materials for application, problem-solving, and alternative test formats (e.g., McDaniel et al., 2013; Pan & Rickard, 2018).

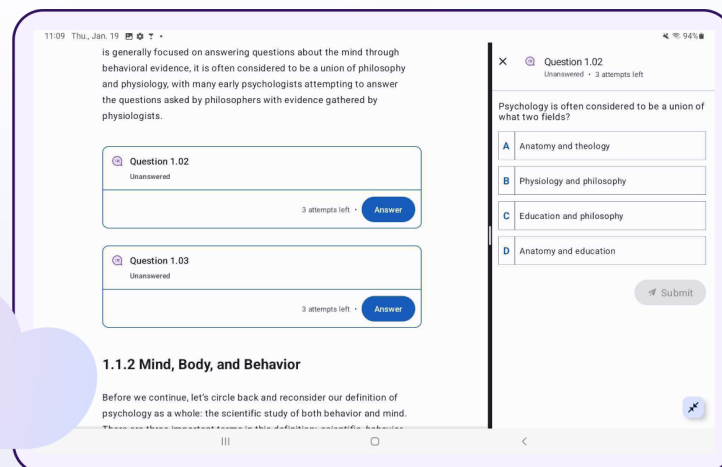
Repeated low-stakes testing can also help students monitor their own learning performance and adjust their study habits as needed. Research suggests that students tend to assess their own abilities prior to testing inaccurately (Carpenter et al., 2022). Feedback provided by low-stakes testing can help students identify knowledge gaps and adjust their studying accordingly (e.g., Butler & Roediger, 2008). Low-stakes practice offers students ways to gauge their own mastery with less anxiety about the results of high-stakes testing, which can subject some students to negative impacts such as stereotype threat (e.g., Pennington et al., 2016). With more frequent assessments, instructors can also make use of more data to uncover potential learning gaps between students to make data-informed changes to close those gaps for more equitable learning across their courses (Montenegro & Jankowski, 2020).

Frequent low-stakes assessments can be done in class while materials are being presented with live classroom responses to give students immediate feedback. They can also be delivered outside of class with students answering questions as they read and interact with content (e.g. Karpicke et al., 2012).

Although the benefits of retrieval practice are well established, implementing it as part of your teaching practice can take considerable effort in addition to grading and feedback. However, with the right technology, this practice can be woven easily into students' learning paths (e.g., Spencer et al., 2020). Top Hat makes it easy for educators to incorporate frequent low-stakes assessments inside and outside of class. For example, questions can easily be integrated between lecture slides, and Top Hat

eTexts can be adopted, authored, or customized with integrated questions throughout text narratives and interactive exercises. Assignments and quizzes can also be easily built with Top Hat Pages to engage students in additional practice outside of class during assigned readings. Studies have shown that using Top Hat to enable retrieval practice is associated with a significant increase in critical thinking skills and students reporting feeling more engaged (Numer & Spencer, 2016). Higher levels of retrieval practice participation with Top Hat have also been linked to higher course grades (e.g., Petto, 2020).

We encourage all educators to put these evidence-based practices to the test in their own course, and see how it can lead to better learning outcomes in their own classrooms.



References

- Benjamin, A.S., & Tullis, J. (2010). What makes distributed practice effective? *Cognitive Psychology*, 61, 228-247.
- Butler, A.C. & Roediger, H.L. (2008). Feedback enhances the positive effects and reduces the negative effects of multiple-choice testing. *Memory and Cognition*, 36, 604-616..
- Carpenter, S.K., Pan, S.C., & Butler, A.C. (2022). The science of effective learning with spacing and retrieval practice. *Nature Reviews Psychology*, 1, 496–511. <https://doi.org/10.1038/s44159-022-00089-1>
- Clark, R. C., & Mayer, R. E. (2011). *E-learning and the science of instruction: Proven guidelines for consumers and designers of multimedia learning*. San Francisco, CA: Pfeiffer.
- Karpicke, J. D., & Blunt, J. R. (2011). Retrieval practice produces more learning than elaborative studying with concept mapping. *Science*, 331(6018), 772-775. <https://doi.org/10.1126/science.1199327>
- Karpicke, J.D., & Grimaldi, P.J. (2012). Retrieval-Based Learning: A Perspective for Enhancing Meaningful Learning. *Educational Psychology Review*, 24, 401–418. <https://doi-org.ezproxy.lib.torontomu.ca/10.1007/s10648-012-9202-2>
- Karpicke, J.D., & Roediger H.L. (2008). The Critical Importance of Retrieval for Learning. *Science*, 319(5865), 966-968. <https://doi.org/10.1126/science.1152408>
- McDaniel, M.A., Thomas, R.C., Agarwal, P.K., McDermott, K.B., & Roediger, H.L. (2013), Quizzing in Middle-School Science: Successful Transfer Performance on Classroom Exams. *Applied Cognitive Psychology*, 27, 360-372. <https://doi.org/10.1002/acp.2914>
- Montenegro, E., & Jankowski, N. A. (2020, January). *A new decade for assessment: Embedding equity into assessment praxis* (Occasional Paper No. 42). Urbana, IL: University Of Illinois and Indiana University, National Institute for Learning Outcomes Assessment(NILOA).
- Numer, M., & Spencer, R. (2016). Technology and the Post-secondary Classroom: A Critical Inquiry into BYOD Student Experience in Human Sexuality. *The International Journal of Technologies in Learning*, 24(1), 1-13. DOI: 10.18848/2327-0144/CGP/v24i01/1-13
- Pan, S. C., & Rickard, T. C. (2018). Transfer of test-enhanced learning: Meta-analytic review and synthesis. *Psychological Bulletin*, 144(7), 710–756. <https://doi.org/10.1037/bul0000151>
- Pennington, C.R., Heim, D., Levy, A.R., Larkin, D.T. (2016). Twenty Years of Stereotype Threat Research: A Review of Psychological Mediators. *PLoS One*, 11(1):e0146487. doi: 10.1371/journal.pone.0146487

Petto, A. (2019). Technology Meets Pedagogy: Comparing Classroom Response Systems. *Journal of College Science Teaching*, 48(4), 55-63.

Roediger, H.R., Agarwal, P.K., McDaniel, M.A., & McDermott, K. B. (2011). Test-Enhanced Learning in the Classroom: Long-Term Improvements from Quizzing. *Journal of Experimental Psychology: Applied*, 17(4), 382-395. DOI: [10.1037/a0026252](https://doi.org/10.1037/a0026252)

Roediger, H.R., & Karpicke, J.D. (2006a). The Power of Testing Memory: Basic Research and Implications for Educational Practice. *Perspectives on Psychological Science*, 1(3), 181-210. <https://doi.org/10.1111/j.1745-6916.2006.00012.x>

Roediger, H.R., & Karpicke, J.D. (2006b). Test-enhanced learning: Taking memory tests improves long-term retention. *Psychological Science*, 17, 249-255. <https://doi.org/10.1111/j.1467-9280.2006.01693.x>

Rohrer, D. (2012). Interweaving helps students distinguish among similar concepts. *Educational Psychology Review*, 24, 355-367.

Smith, M.A. & Karpicke, J.D. (2014). Retrieval practice with short-answer, multiple-choice, and hybrid tests. *Memory*, 22, 784-802.

Spencer, R., Sinno, J., Hatfield, K., Biderman, M., Doria, N., & Numer, M. (2020). Exploring Top Hat's Impact on Undergraduate Students' Belongingness, Engagement, and Self-

Confidence: A Mixed Methods Study, *Journal of Research on Technology in Education*, 52(2), 197-215. <https://doi.org/10.1080/15391523.2020.1722977>

