

FIVE PRINCIPLES of LEARNING

MORTON ANN GERNSBACHER, PH.D



DISTRIBUTED vs MASSED PRACTICE

A core principle of learning is that shorter, more-frequent episodes of practice lead to better mastery than longer, less-frequent episodes.

Acquiring skills through more-frequent practice is considered distributed learning, whereas acquiring skills through less-frequent practice is considered massed learning. Distributed learning almost always trumps massed learning.

Distributed learning's advantage over massed learning has been demonstrated for students of all ages, acquiring mastery in a wide range of courses. "Harness the pedagogical power of distributed learning" has been one of the most common battle cries for improving higher education.

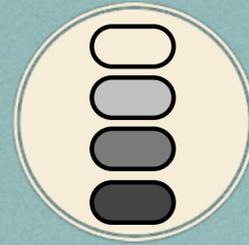


OPTIMAL TIME of THE DAY

Psychological science, as well as personal observation, identifies differences among us in our optimal time of the day. Our cognitive processes peak at our optimal times and flounder at our non-optimal times.

Empirical research documents that every cognitive process – memory, attention, language, even intelligence testing, and attitude change – operates at a peak during our optimal time of the day.

By puberty, students' optimal time of the day has already shifted beyond the traditional school day to evening. Even if students try to get a good night of sleep, their biology dictates against morning hours bringing their optimal performance.



LEVELS of PROCESSING

Psychological science documents the value of deeper levels of processing. Information that is processed to a deeper level is remembered better; more deeply processed information is also more tightly connected to previously learned and subsequently learned concepts.

Internet-based learning can deepen levels of processing for one simple reason: To allay concerns about cheating, assignments and exams must assess deeper levels of processing.

Indeed, if the answer to a question, or the solution to a problem, is just a click away – be the assignment Internet-based or in-person – we should probably not be assessing such superficial knowledge in our higher education courses.



CRITICAL THINKING and ACTIVE LEARNING

A few years ago, a group of psychology students refused to spend \$168 to purchase the course textbook. Instead, they gathered all the information for their course using only the Internet.

How did these students fare? Top of the class. Surprised?

The accuracy of information on the Internet, although commonly underestimated, is one factor that led to the students' success.

The other factor was that the process of gathering information from the Internet evokes more critical thinking than simply reading a textbook. Active learning – winnowing and sifting intellectual wheat from chaff – facilitates learning.



DAILY WRITING for PEERS

After critical thinking skills, writing skills are what employees consistently rank as necessary in college graduates. Internet-based higher education can enhance students' writing skills by capitalizing on the Internet's inherently text-based mode of communication.

Across one term of my courses, each student writes approximately 75 posts, with each post comprising two to three paragraphs. In essence, each student writes the equivalent of a five-page double-spaced paper each of 15 weeks.

Who reads the equivalent of 50 students' five-page papers each week? I read a sample of them, but the primary readers are the other students in the class.

REFERENCES

- American Academy of Pediatrics (2014). School start times for adolescents. *Pediatrics*. doi: 10.1542/peds.2014-1697
- Association of American Colleges and Universities and Hart Research Associates (2013). *It takes more than a major: Employer priorities for college learning and student success*. Washington, DC: Association of American Colleges and Universities.
- Benjamin, A. S., & Tullis, J. (2010). What makes distributed practice effective? *Cognitive Psychology*, 61, 228-247.
- Budé, L., Imbos, T., van de Wiel, M. W., & Berger, M. P. (2010). The effect of distributed practice on students' conceptual understanding of statistics. *The International Journal of Higher Education Research*. doi: 10.1007/s10734-010-9366-y
- Chi, M. T. H. (2009). Active-constructive-interactive: A conceptual framework for differentiating learning activities. *Topics in Cognitive Science*, 1, 73-105.
- Craik, F. I. M. (2010). Levels of processing in human memory. In M. A. Gernsbacher, R. W. Pew, L. M., Hough, & J. R. Pomerantz (Eds.), *Psychology and the real world: Essays illustrating fundamental contributions to society* (pp. 76-82). New York: Worth Publishers.
- Day, T. M., Raven, M. R., & Newman, M. E. (1998). The effects of world wide web instruction and traditional instruction and learning styles on achievement and changes in student attitudes in a technical writing in an agricomunication course. *Journal of Agricultural Education*, 39, 65-75.
- Ellison, N. B., & Wu, Y. (2005). Blogging in the classroom: A preliminary exploration of student attitudes and impact on comprehension. *Journal of Educational Multimedia and Hypermedia*, 17, 99-122.
- Elvers, C., Polzella, D. J., & Graetz, K. (2003). Procrastination in online courses: Performance and attitudinal differences. *Teaching of Psychology*, 30, 159-162.
- Fishman, J., Lunsford, L., McGregor, B., & Otuteye, M. (2005). Performing writing, performing literacy. *College Composition and Communication*, 57, 224-252.
- Foertsch, J., & Gernsbacher, M. A. (2008). When the medium illuminates the content: Exploiting the unique features of online communication in an undergraduate psychology course. *Innovate: Journal of Online Education*, 4, 3.
- Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Science USA*, 111, 8410-8415.
- Gaddis, B., Napierkowski, H., Guzman, N., & Muth, R. (2000). A comparison of collaborative learning and audience awareness in two computer-mediated writing environments. ERIC Document Number: ED455771. Retrieved from <http://eric.ed.gov/?id=ED455771>.
- Gernsbacher, M. A. (2013). Improving scholarly communication: An online course. University of Wisconsin-Madison. Retrieved from <http://www.gernsbacherlab.org/research/online-communication-research/online-courses/>.
- Gernsbacher, M. A. (2014). Internet-based communication. *Discourse Processes*, 51, 359-373.
- Gernsbacher, M. A. (2015). Why Internet-based education? *Frontiers in Psychology*, 5:1530. doi:10.3389/fpsyg.2014.01530
- Giles, J. (2005). Internet encyclopaedias go head to head. *Nature*, 438, 900-901.
- Goldstein, D., Hahn, C. S., Hasher, L., Wiprzycka, U. J., & Zelazo, P. D. (2007). Time of day, intellectual performance, and behavioral problems in morning versus evening type adolescents: Is there a synchrony effect? *Personality and Individual Differences*, 42, 431-440.
- Holzinger, A., Kickmeier-Rust, M. D., & Ebner, M. (2009). Interactive technology for enhancing distributed learning: A study on weblogs. *HCI 2009: People and Computers*, 23, 309-312.
- Kaplan, D. S., Rupley, W. H., Sparks, J., & Holcomb, A. (2007). Comparing traditional journal writing with journal writing shared over e-mail list serves as tools for facilitating reflective thinking: A study of preservice teachers. *Journal of Literacy Research*, 39, 357-387.
- Keller, J. (2009, June 11). Studies explore whether the Internet makes students better writers. *The Chronicle of Higher Education*. Retrieved from <http://chronicle.com/article/Studies-Explore-Whether-the-44476/>.
- Kellogg, R. T., & Raulerson, B. A. III (2007). Improving the writing skills of college students. *Psychonomic Bulletin & Review*, 14, 237-242.
- Kim, S., Dueker, G. L., Hasher, L., & Goldstein, D. (2002). Children's time of day preference: Age, gender and ethnic differences. *Personality and Individual Differences*, 33, 1083-1090.
- Martin, P. Y., & Marrington, S. (2005). Morningness-eveningness orientation, optimal time-of-day and attitude change: Evidence for the systematic processing of a persuasive communication. *Personality and Individual Differences*, 39, 367-377.
- Massis, B. E. (2013). Textbook affordability: The library's role. *New Library World*, 114, 179-183.
- May, C. P. (1999). Synchrony effects in cognition: The costs and a benefit. *Psychonomic Bulletin & Review*, 6, 142-147.
- May, C. P., & Hasher, L. (1998). Synchrony effects in inhibitory control over thought and action. *Journal of Experimental Psychology: Human Perception and Performance*, 24, 363-379.
- May, C. P., Hasher, L., & Stoltzfus, E. R. (1993). Optimal time of day and the magnitude of age differences in memory. *Psychological Science*, 4, 326-330.
- Natale, V., & Lorenzetti, R. (1997). Influences of morningness-eveningness and time of day on narrative comprehension. *Personality and Individual Differences*, 23, 685-690.
- Newlin, M. H., & Wang, A. Y. (2002). Integrating technology and pedagogy: Web instruction and seven principles of undergraduate education. *Teaching of Psychology*, 29, 325-330.
- Oseas, L., & Underwood, B. J. (1952). Studies of distributed practice: V. Learning and retention of concepts. *Journal of Experimental Psychology*, 43, 143-148.
- Prince, M. (2004). Does active learning work? A review of the research. *Journal of Engineering Education*, 93, 223-231.
- Purcell, K., Buchanan, J., & Friedrich, L. (2013). The impact of digital tools on student writing and how writing is taught in schools. *PewResearch Internet Project*. Retrieved from www.pewinternet.org/2013/07/16/the-impact-of-digital-tools-on-student-writing-and-how-writing-is-taught-in-schools/.
- Randall, D. K. (2012). *Dreamland: Adventures in the strange science of sleep*. New York: W. W. Norton & Company.
- Reynolds, J. H., & Glaser, R. (1964). Effects of repetition and spaced review upon retention of a complex learning task. *Journal of Educational Psychology*, 55, 297-308.
- Roediger, H. L. III, & Pyc, M. A. (2012). Inexpensive techniques to improve education: Applying cognitive psychology to enhance educational practice. *Journal of Applied Research in Memory and Cognition*, 1, 242-248.
- Ruch, T. C. (1928). Factors influencing the relative economy of massed and distributed practice in learning. *Psychological Review*, 35, 19-45.
- Seabrook, R., Brown, G. D. A., & Solity, J. E. (2005). Distributed and massed practice: From laboratory to classroom. *Applied Cognitive Psychology*, 19, 107-122.
- Selingo, J. (2013). *College unbound: The future of higher education and what it means for students*. New York: New Harvest.
- Sternberg, R. J. (2013, June 17). Giving employers what they don't really want. *The Chronicle of Higher Education*. Retrieved from <http://chronicle.com/article/Giving-Employers-What-They-139877>.
- Thompson, C. (2009, August 24). Clive Thompson on the New Literacy. *Wired Magazine*. Retrieved from http://archive.wired.com/techbiz/people/magazine/17-09/st_thompson.
- Tsui, L. (1999). Courses and instruction affecting critical thinking. *Research in Higher Education*, 40, 185-200.
- U.S. Department of Education (2010). *Evaluation of evidence-based practices in online learning: A meta-analysis and review of online learning studies*. Washington, DC: Office of Planning, Evaluation, and Policy Development.
- Underwood, B. J. (1961). Ten years of massed practice on distributed practice. *Psychological Review*, 68, 229-247.
- Weiler, A. (2004). Information-seeking behavior in Generation Y students: Motivation, critical thinking, and learning theory. *The Journal of Academic Librarianship*, 31, 46-53.
- West, R., Murphy, K. J., Armilio, M. L., Craik, F. I. M., & Stuss, D. T. (2002). Effects of time of day on age differences in working memory. *Journal of Gerontology*, 57B, 3-10.
- Willingham, D. T. (2002). Ask the Cognitive Scientist. Allocating student study time: "Massed" versus "Distributed" practice. *American Educator*, 26, 37-39.