SPACING EFFECT AND MNEMONIC STRATEGIES: A THEORY-BASED APPROACH TO E-LEARNING

Rehana Mubarak
LearnLift
Oberes Ried 1
6833 Klaus
Austria

Daniela C. Smith
LearnLift
Oberes Ried 1
6833 Klaus
Austria

ABSTRACT

This work briefly reviews pertinent research on learning and memorization. Specifically, it has been demonstrated that spaced repetition and targeted mnemonic strategies greatly facilitate the learning process and foster long-term recall. One possibility to apply these principals is their incorporation into specialized e-learning tools such as MemoryLifter, a free educational software, which is introduced. The software features a timed multimedia learning environment based on the Leitner algorithm and incorporates mnemonic elements to enhance the learning experience.

KEYWORDS

e-learning, flashcards, memorization, spaced repetitions, mnemonics, Leitner, MemoryLifter.

1. INTRODUCTION

More than 100 years ago, Hermann Ebbinghaus was the first to conduct an experimental investigation of human memory (Ebbinghaus, 1885). Since then, memory and knowledge recall have been investigated in hundreds of studies, resulting in a systematic body of knowledge about the mechanisms of learning.

What is truly remarkable, however, is that despite the soundness of the discovered phenomena, practical applications of these findings are still rare. Only recent research has attempted to create a synthesis of theory and practice, and to formulate a set of guidelines that can directly be applied by students (for example, Pashler et al, 2007). However, as of yet, there are very few learning tools which incorporate scientifically validated principles to create a highly productive and individualized learning environment.

In this paper, we briefly introduce pertinent research findings in the field of memory and learning, such as the role of the spacing effect and mnemonic strategies, to improve knowledge retention and recall. Finally, we introduce MemoryLifter, a free educational software that combines these various elements to greatly enhance learning efficiency.

2. BODY OF PAPER

In his seminal work "*Über das Gedächtnis"*, Ebbinghaus tracked his own ability to memorize and recall a set of nonsense syllables, which had no pre-established associations in his memory. In doing so, he created the world's first learning and forgetting curves. More importantly, however, he was the first to describe what would later be known as the spacing effect. Ebbinghaus found that reviews of material to be memorized are most effective if they come at spaced intervals (Ebbinghaus, 1885). Simply put, memory performance is worse when material is reviewed immediately (massed repetitions); considerably more learning takes place

when time elapses between reviews (spaced repetitions). The spacing effect has proven to be one of the most reliable psychological phenomena. It occurs with a wide variety of tasks and testing procedures, and has been validated in numerous studies (see Cepada et al, 2006; Dempster, 1989; Greene, 1989; and Raaijmakers, 2003 for recent reviews of related research).

In the early 1970's Sebastian Leitner developed a flashcard study system that employs spaced repetition to maximize long-term retention of study material (Leitner, 1972). In this system, flashcards are sorted into boxes according to how well they are known. If card content can be recalled the flashcard is promoted to a higher box. Because box sizes increase ascendingly, and a card in a higher box is only retested, when the box is filled, increasing time lags in between learning repetitions are created. If at any time card content cannot be recalled the flashcard is demoted to box one again (see Figure 1).

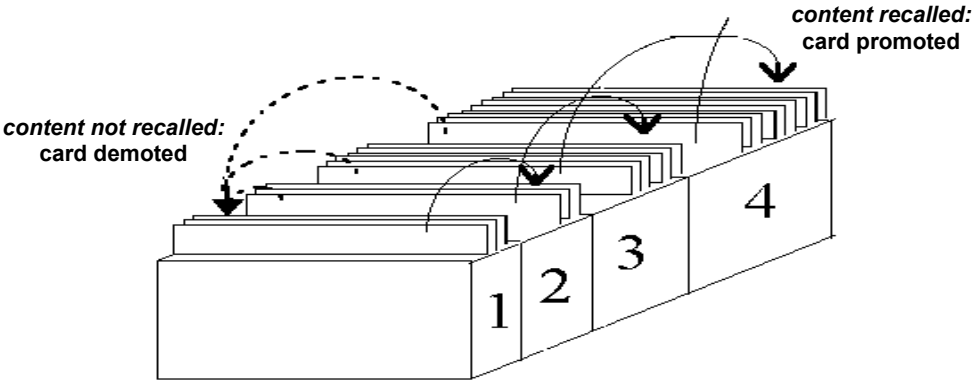

Figure 1. Schematic representation of Leitner study system

Another factor that positively influences retention rate is the incorporation of mnemonic items. Being derived from the ancient Greek word *mnemonico*s ("of memory"), the term "mnemonic strategy" denotes the usage of items such as acronyms, rhymes, visual information or stories that improve memory storage and retrieval. Mnemonic strategies can also be actively used for instruction to "improve recall by systematically integrating specific retrieval routes within to-be-learned content" (Scruggs and Mastropieri, 1992), and have been shown effective for learning facts and data in a wide variety of subjects and for learners of all ages (Carney and Levin, 2000). It should be kept in mind, though, that mnemonic associations are influenced by cultural background and personal history.

The ideal learning tool should incorporate these scientific principles. Indeed, there have been some attempts to design an optimal learning tool. For example, de Boer (2003) described a theoretical framework for a Computer Assisted Language Learning (CALL) tool. Based on prior research on the spacing effect, he calculated the most efficient presentation schedule for vocabulary learning. However, approaches like these are the exception rather than the rule, and the average student is still hard pressed to gain access to an optimized learning instrument that is applicable to a variety of uses and easily customized.

MemoryLifter, a free educational software based on the Leitner algorithm, combines the benefits of spaced learning with mnemonic strategies (LearnLift, 2008). The software employs virtual, multimedia flashcards that can incorporate images, audio, and video material (see Figure 2).

Flashcards are quizzed, sorted into virtual boxes of increasing size and subsequently presented to the learner at spaced time intervals (see Figure 1). One main advantage of this system is the highly individualized study environment that is created. For example, the speed of the learning and the number of repetitions are completely dependent on the individual progress of each user. Learning is highly targeted to the material that is not yet mastered, because card content that is not known (or has been forgotten) is presented at a higher frequency, while repetitions of material that is already known are reduced.

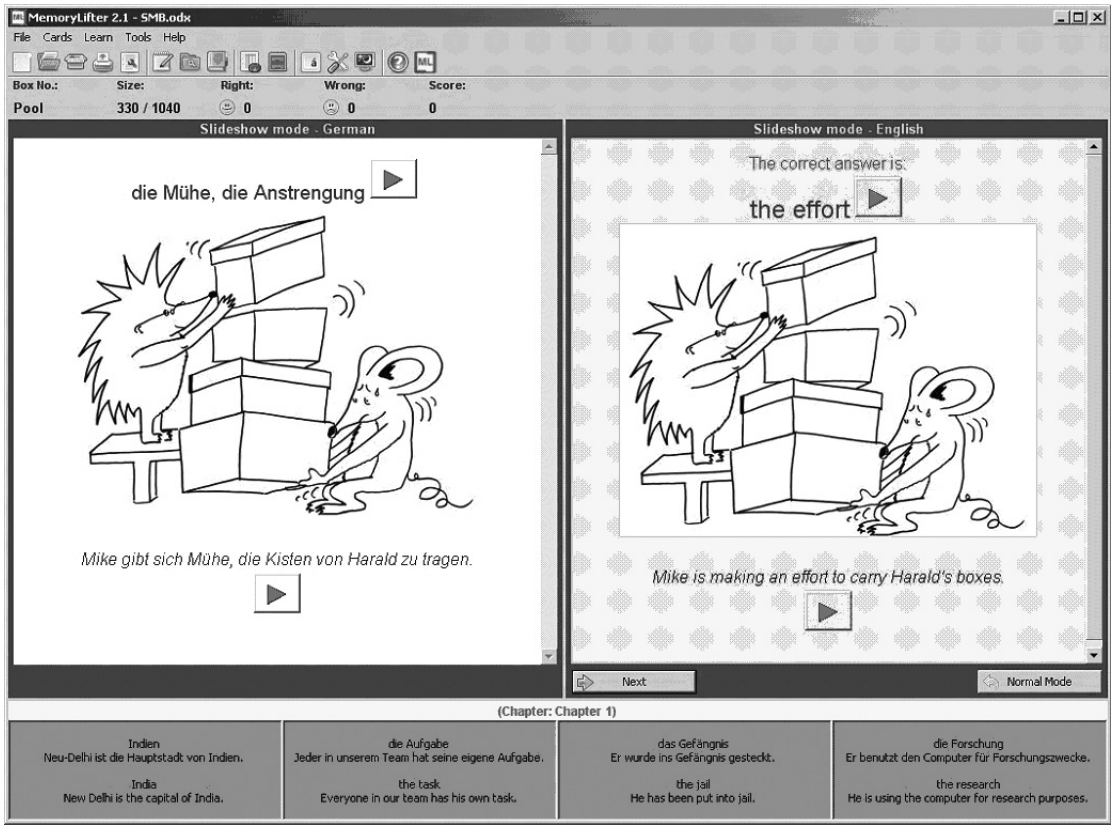

Figure 2. Black-and-white screenshot of a MemoryLifter vocabulary learning module

At the same time, MemoryLifter features a range of sophisticated card editing and maintenance tools, which allow the user to easily create his/her own multi-media learning modules or to customize existing learning modules with additional flashcards and desired mnemonic elements like images or audio files.

Because of these features, the software is very versatile. Most other learning software is specialized to a specific subject, very often languages. User feedback has shown that MemoryLifter has successfully been used to study a wide variety of subjects in a number of fields, ranging from languages, military sciences, social- and natural sciences to medical sciences.

3. CONCLUSION

Research on memory and learning has created a solid body of knowledge in the field. Today, few would dispute that spaced repetition over time is more beneficial than late night cramming sessions, or that enhancing study material with mnemonic elements will facilitate long-term recall. It is all the more surprising then, that so little of these findings have found their way into the classrooms around the world, and few e-learning programs have incorporated these principles. MemoryLifter shows how it can be done. The software has integrated spaced learning and mnemonic elements, to create a highly individualized and efficient learning solution.

To be sure, MemoryLifter, like most other learning software, has its limitations. Learning software cannot be a substitute for a teacher and the social interactions that take place in the classroom environment. MemoryLifter is designed to make the tedious memorization work, which for many subjects is an integral part of learning, as efficient as possible. Conceptual understanding will in many cases follow naturally, when the mind is no longer occupied with the task of memorizing facts (Dempster, 1991).

REFERENCES

Carney, R. N., & Levin, J. R., 2000. Mnemonic instruction with a focus on transfer. Journal *of Educational Psychology,* Vol. 92, No. 4, pp. 783–790.

Cepeda, et al, 2006. Distributed practice in verbal recall tasks: A review and quantitative synthesis. *Psychological Bulletin*, Vol. 132, pp. 354-380.

de Boer, V., 2003. *Optimal Learning and the Spacing Effect: Theory, Application and Experiments based on the Memory Chain Model*. Artificial Intelligence Master's Thesis. University of Amsterdam.

Dempster, F.N., 1991. Synthesis of Research on Reviews and Tests. *Educational Leadership,* April, pp. 71-76.

Dempster, F.N., 1989. Spacing Effects and Their Implications for Theory and Practice. *Educational Psychology Review,* Vol. 1, No. 4, pp. 309-330.

Ebbinghaus, H., 1885. *Über das Gedächtnis: Untersuchungen zur experimentellen Psychologie.* New unchanged and unshortened Edition 1992. Wissenschaftliche Buchgesellschaft, Darmstadt, Germany.

Greene, R. L., 1989. Spacing effects in memory: Evidence from a two-process account. *Journal of Experimental Psychology: Learning, Memory, and Cognition,* Vol. 15, pp. 371-377.

Kornell, N. and Bjork, R.A. 2007. The promise and perils of self-regulated study. Vol. 14, No. 2, pp. 219-224.

LearnLift, 2008. MemoryLifter Educational Software, free download at <http://www.memorylifter.com>

Leitner, S., 1972. *So lernt man lernen. Angewandte Lernpsychologie – ein Weg zum Erfolg.* Verlag Herder, Freiburg im Breisgau, Germany.

Pashler, H., et al, 2007. Enhancing learning and retarding forgetting: choices and consequences. *Psychonomic Bulletin & Review,* Vol. 14. No. 2, pp. 187-193.

Raaijmakers, J. G. W., 2003. Spacing and repetition effects in human memory: Application of the SAM model. *Cognitive Science,* Vol. 27, pp. 431-452.

Scruggs, T. E., and Mastropieri, M. A., 1992. Classroom applications of mnemonic instruction: Acquisition, maintenance and generalization. *Exceptional Children,* Vol. 58, pp. 219-229.