
SPACED REPETITION:
A METHOD FOR LEARNING MORE LAW IN LESS TIME

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Abstract

Spaced repetition is a learning method that allows people to learn far more, in far less time. Discovered more than 100 years ago, recent advances in mobile technology have made its potential even greater to change the way law students, bar preppers and others in the legal field learn. This article describes the science of spaced repetition and its potential uses in law. It also describes the author's work in building a platform for law students, SpacedRepetition.com, to allow them to harness this technology.

Early findings are both exciting and consistent with the benefits of this method found in other fields. In one recent use of the technology, an entire graduating law school class was offered the chance to use SpacedRepetition.com to supplement their traditional bar preparation courses. Those who used the spaced

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repetition method passed the bar exam at a rate 19.2% higher than students who did not make use of it.

“For our whole education depends upon memory, and we shall receive instruction all in vain if all we hear slips from us.”¹

-Quintilian

I. Introduction

Imagine that you are a law student researching ways to maximize your chances of passing the bar exam. Now imagine that, in your research, you discover a method that has been proven to allow users to remember nearly four times more than other methods,² as well as to dramatically improve performance on tests.³ You find that it has been thoroughly studied and shown effective, time-and-again, for more than 100 years.⁴ You also learn that this method has been

¹ 11 MARCUS FABIVS QVINTILIANVS, INSTITVTIO ORATORIA 213 (Harold Edgeworth Butler trans., 1932).

² See Piotr Wozniak, Optimization of Learning, § 3.2 (May 10, 1998) (unpublished M.S. thesis, University of Technology in Poznan) (on file with SuperMemo) (comparing commonly used open-source “SR” algorithm with traditional means of memory retention). SR has a 92% retention rate, while a traditional forgetting curve for people who cram information then later try to recall it is approximately 20-25% over the same time intervals. *Id.*

³ See B. Price Kerfoot et al., *Online “Spaced Education Progress-Testing” of Students to Confront Two Upcoming Challenges to Medical Schools*, 86 ACAD. MED. 300, 303 (2011) (controlling for MCAT scores while progress testing); John J. Donovan & David J. Radosevich, *A Meta-Analytic Review of the Distribution of Practice Effect: Now You See It, Now You Don’t*, 84 J. APPLIED PSYCHOL. 795, 796 (1999) (focusing on how learning and performance are affected by the type of task at hand).

⁴ See *infra* Section II (discussing the background and development of Spaced Repetition).

called the single best way to study by the Association for Psychological Science,⁵ “the new way doctors learn” by Time Magazine,⁶ and been recommended in the New York Times,⁷ Wall Street Journal⁸ and Harvard Business Review.⁹ You find that celebrity proponents of the method include everyone from a Wikipedia founder¹⁰ to the all-time record holder for single-day winnings on Jeopardy!¹¹ In one recent use case of this method in legal education, an entire graduating law school class was given the option to use this technology.¹² Students who chose to do so passed the bar exam at a rate 19.2% higher than classmates who did not.¹³ You learn that this result is consistent with the decades of research on the effectiveness of

⁵ See John Dunlosky, et al., *Improving Students' Learning With Effective Learning Techniques: Promising Directions From Cognitive and Educational Psychology*, 14 PSYCHOL. SCI. PUB. INT. 4, 46 (2013) (illustrating that certain practices, such as Distributed Practice and Spaced Repetition, have a higher or lower utility for different types of learners).

⁶ See Annie Murphy Paul, *The New Way Doctors Learn*, TIME (Mar. 7, 2012), archived at <https://perma.cc/PG6L-WPGL> (discussing the study tool developed by B. Price Kerfoot and how it has helped medical student achieve better test results).

⁷ See Henry L. Roediger III, *How Tests Make Us Smarter*, N.Y. TIMES (July 18, 2014), archived at <https://perma.cc/GXR2-474J> (exploring the ways in which testing can help improve learning). “[R]etrieving knowledge from memory is more beneficial when practice sessions are spaced out so that some forgetting occurs before you try to retrieve again. The added effort required to recall the information makes learning stronger.” *Id.*

⁸ See Sue Shellenbarger, *Flashcards Get Smarter So You Can, Too*, WALL STREET J. (Apr. 28, 2015), archived at <https://perma.cc/TR3X-ZQSA> (recommending flashcard use when studying).

⁹ See H. James Wilson, *Here's a Better Way to Remember Things*, HARV. BUS. REV. (Dec. 11, 2012), archived at <https://perma.cc/UM7T-JTFG> (describing new methods to improve your memory).

¹⁰ See Larry Sanger (@lsanger), TWITTER (Jan. 10, 2013), archived at <https://perma.cc/SC4R-VJ4R> (stating that “[i]f I were still teaching college, I would REQUIRE my students to review question stacks that I had added to a spaced repetition program.”).

¹¹ See STEPHEN BAKER, FINAL JEOPARDY: MAN VS. MACHINE AND THE QUEST TO KNOW EVERYTHING 212 (2011) (discussing the success of Roger Craig, a computer scientist who was deemed “a monster” on jeopardy for his wildly successful “one-game scoring record with a \$77,000 payday”).

¹² See 07/07/2016 Administrative Actions, 2016-Ohio-4826 (2016) (listing the persons who applied to take the July 2016 Ohio Bar Examination).

¹³ See *id.* (providing list of persons from graduating law school who applied to take the July 2016 Ohio Bar Examination and used spaced repetition to study); see also research records on file with the author (illustrating pass rates for students who used spaced repetition who took the Ohio Bar examination).

this method, including a finding that medical students preparing for their boards remembered nearly three times as much when using this technique.¹⁴

So, if *you* were this hypothetical law student preparing for the bar (or, for that matter, a law professor or law school dean interested in helping your students), would you be interested in learning more? If so, read on.

What you have discovered is "spaced repetition" ("SR").¹⁵ This learning and memorization method has the potential to improve the way law students learn and prepare for exams, and this paper explores it. Discovered in the 1800s, SR has only now become feasible outside of the lab because modern technology, particularly smart phones and the internet, make it apply and modify a special algorithm that works to best help each individual user.¹⁶

SR is an alternative to traditional "cramming" and has been proven to help users retain knowledge for the long-term with less study time and greater retention rates.¹⁷ Its effectiveness is based on a combination of scientific factors, but it's simple to apply: users look at electronic flashcards on their smart phone or computer, rate how well they knew the answer, then review the card again when prompted based on an algorithm working behind the scenes.¹⁸ When matched with excellent content on the cards, SR users become much more efficient and effective learners and test-takers.¹⁹

¹⁴ See Kerfoot et al., *supra* note 3, at 303 (illustrating the effectiveness of the spaced education process-testing in aiding medical students study for exams).

¹⁵ See *What is Spaced Repetition?*, FLASHCARD LEARNER, archived at <https://perma.cc/G7EY-CMSE> (defining Spaced Repetition as a "learning technique . . . that [helps] you review information at gradually increasing intervals").

¹⁶ See *infra* Sections II and III (exploring how Spaced Repetition developed and the effectiveness of this method of studying).

¹⁷ See Sean Kang, *Ask the Scientist: Which is the Best Way to Study? How Often? Does Cramming Work?*, TEMPORAL DYNAMICS OF LEARNING CTR. (2010), archived at <https://perma.cc/A4R5-F2TK> (discussing best practices for studying from a cognitive scientist's perspective).

¹⁸ See Patricia A. deWinstanley & Robert A. Bjork, *Successful Lecturing: Presenting Information in Ways That Engage Effective Processing*, 89 NEW DIRECTIONS FOR TEACHING & LEARNING 19, 24 (2002) (observing positive results and efficiency from implementation of spaced repetition instruction).

¹⁹ See Odilia R. Erkaya & Iris S. Drower, *Perceptions of an EL Learner on Vocabulary Development*, 27 INT'L J. SPECIAL EDUC. 81, 85-86 (2012) (highlighting use of note cards for studying a foreign language as an effective application of spaced repetition).

To grasp the potential for SR, consider the bar exam: to prepare, students typically complete three years of full-time courses, then, after graduating, take an expensive commercial bar preparation course, during which they spend three months studying full-time.²⁰ Still, for many, the difference between failure and success on the bar exam can be a razor's edge.²¹

What if, for every student on that edge of failing, we could give them eight more points on the bar, and save them some time in the offing?²² That is exactly what SR appears capable of doing.²³ A study summarizing the results of over fifty 20th century studies testing SR showed that users of this method improved testing results by at least half a standard deviation.²⁴ Translating that advantage to the multi-state portion of the bar exam (to say nothing of any advantage it might provide on essay portions), a half a standard deviation improvement would bring a bar examinee earning eight extra points on the MBE alone.²⁵ The effect: many who would fail the bar would now pass.²⁶

²⁰ See Brian Dalton, *Which Bar Exam Prep Course is the Best?*, ABOVE THE LAW (May 21, 2013), archived at <https://perma.cc/5N7A-BHQB> (outlining bar examination preparation process and costs for law school graduates).

²¹ See Andy Mergendahl, *The Bar Exam: Why Some Fail*, LAWYERIST (Aug. 1, 2011), archived at <https://perma.cc/D5EQ-NNPF> (analyzing the reasons why some law school graduates fail the bar exam).

²² See Team Learn Sheets, *Performance Test Strategy: Simple Trick to Add 5 or More Points to Your Score*, LEAN SHEETS (last visited Feb. 6, 2017), archived at <https://perma.cc/2DVC-KZNM> (discussing unique ways to increase your score by studying more efficiently).

²³ See *What is Spaced Repetition?*, *supra* note 15 (suggesting that spaced repetition results in more efficient retention of information). By helping students increase the amount of information they retain while decreasing the amount of time and effort spent on memorization, they will be more prepared and perform better on the Bar Exam. *Id.*

²⁴ See Donovan & Radosevich, *supra* note 3, at 801 (summarizing the findings of the author's research). The improvement demonstrated in the study reflect outdated technology and, presumably, the results would be even better with the use of Internet and smart phone technology. *Id.*

²⁵ See Donovan & Radosevich, *supra* note 3 (applying the results from the study to law students taking the bar exam).

²⁶ See *2012 Statistics*, NATIONAL CONFERENCE OF BAR EXAMINERS (Apr. 11, 2013), archived at <https://perma.cc/56ND-GZLX> (quantifying the average MBE passing scores). For 2012, the mean MBE score was 141.6 and the standard deviation is 15.8. *Id.* Assuming a normal distribution, a predicted half standard deviation benefit by using SRS would play out as follows: a 5th centile score of 116 improves to 13th centile, score predicted to be 124; a 10th centile score of 121

In the following pages, this article explains in greater detail how SR works,²⁷ and summarizes the research behind it.²⁸ The article will then explain the role SR can play in legal education, together with a plan to implement it.²⁹ This article also describes the platform that I have built with the hopes of ultimately providing a tool to help all legal professionals improve their learning.³⁰

II. What Spaced Repetition Is and How it Works

SR works because it allows for harnessing of three psychological phenomena that aid learning and memory: (1) the *forgetting curve* dictates that we can predict when a person will forget information; (2) the *spacing effect* shows that studying just before we would predict forgetting causes exponential benefits in remembering; and (3) the *testing effect* stands for the principle that testing oneself along the way reinforces these benefits.³¹ Below, this section provides a more detailed summary of how each of these phenomena work.

A. The Forgetting Curve

improves to 21st centile, score predicted to be 129; a 15th centile score of 125 improves to 29th centile, score predicted to be 133; a 20th centile score of 128 improves to 37th centile, score predicted to be 136; a 25th centile score of 131 improves to 43rd centile, score predicted to be 139; a 30th centile score of 133 improves to 49th centile, score predicted to be 141. *Id.*

²⁷ See *infra* Part III (summarizing science of SR).

²⁸ See *infra* Part IV (describing key research on SR).

²⁹ See *infra* Part V (applying SR research to legal education).

³⁰ See SERIOUS SOFTWARE FOR SERIOUS LAW STUDENTS (last visited Jan. 23, 2017), archived at <https://perma.cc/M8P9-2KXH> (explaining on the home page of the website that was created to help improve learning and exam passage rates).

³¹ See HERMANN EBBINGHAUS, MEMORY: A CONTRIBUTION TO EXPERIMENTAL PSYCHOLOGY 76 (Henry A. Ruger & Clara E. Bussenius trans., Columbia Univ., 1913) (1885) (discussing the “forgetting curve” and when people are most likely to remember the most information); see also Nicholas J. Cepeda et al., *Spacing Effects in Learning A Temporal Ridgeline of Optimal Retention*, 19 PSYCH. SCI. 1095, 1095 (2008) (explaining studies undergone by the “spacing effect”); Henry L. Roediger, III & Jeffrey D. Karpicke, *Test-Enhanced Learning: Taking Memory Tests Improves Long-Term Retention*, 17 PSYCH. SCI. 249, 249 (2006) (stating that frequent testing will help to better retain relevant information).

Memories decay with time.³² This is an almost universal experience and scholars of memory describe the predictable decline in the probability of recall as the “forgetting curve.”³³ Recognition, and identification, of the forgetting curve is vital to SR because SR cues users to restudy immediately *before* information users have learned is predicted to be forgotten based on that individual’s forgetting curve.³⁴ The value of doing this is based on the empirically-documented insight that there is an ideal moment at which to reinforce a piece of information to help one retain it: wait too long, information is not recalled at all; study too soon and time is wasted time because it is recalled too readily.³⁵

The forgetting curve was discovered by a German psychologist, Hermann Ebbinghaus, in 1885.³⁶ To demonstrate it, Ebbinghaus had subjects memorize a series of nonsensical syllables and tested recall of them at various periods of time, from twenty minutes to one month, after they initially learned them.³⁷ By repeatedly testing subjects’ ability to remember the syllables after various delays from first learning them, he was able to describe the shape of the forgetting

³² See EBBINGHAUS, *supra* note 31, at 76 (proposing that all ideas will eventually be forgotten if unenforced).

³³ See EBBINGHAUS, *supra* note 31, at 76 (characterizing the “forgetting curve” as the process of forgetting information more rapidly as time progresses).

It will probably be claimed that the fact that forgetting would be very rapid at the beginning of the process and very slow at the end should have been foreseen. However, it would be just as reasonable to be surprised at this initial rapidity and later slowness as they come to light here.

Id.

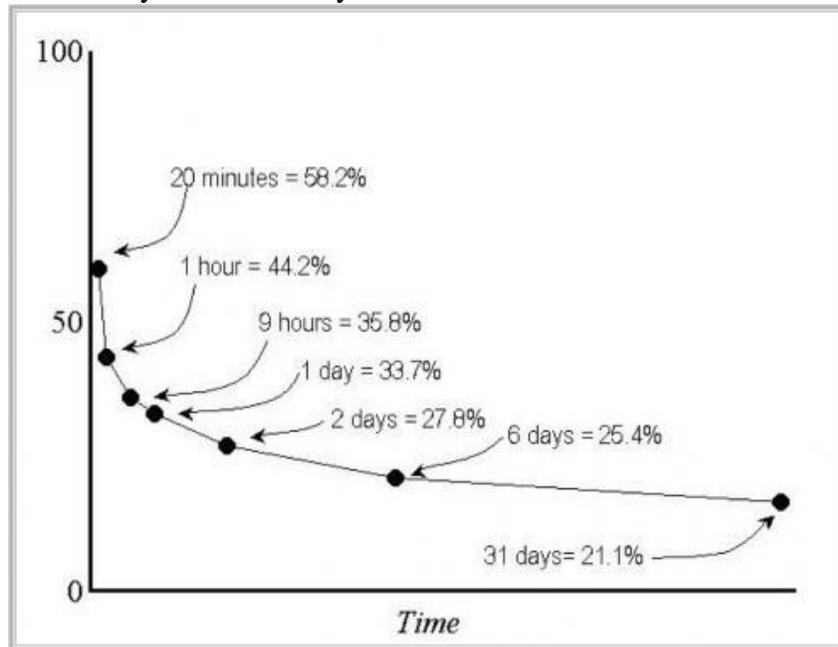
³⁴ See John T. Wixted & Ebbe B. Ebbesen, *On the Form of Forgetting*, 2(6) PSYCHOL. SCI. 409, 413 (1991) (discussing the percent decline in memory as related to the forgetting curve).

³⁵ See Gary Wolf, *Want to Remember Everything You’ll Ever Learn? Surrender to This Algorithm*, WIRED (Apr. 21, 2008), archived at <https://perma.cc/BN4P-JR8W> (describing the algorithm that predicts the most efficient time for memory reinforcement).

³⁶ See snasta, *Overcoming the Ebbinghaus Forgetting Curve—How Soon We Forget*, E-LEARNING COUNCIL (June 5, 2010), archived at <https://perma.cc/MCN5-HPV3> (indicating that in 1885 Ebbinghaus’ experimentation with memorization of words led to the discovery of the learning curve, also known as the Ebbinghaus Curve).

³⁷ See EBBINGHAUS, *supra* note 31, at 76 (listing methods of testing memorization of syllables by subjects).

curve and demonstrate the exponential rate at which learned information decays from memory.³⁸



Source: snasta, *Overcoming the Ebbinghaus Forgetting Curve—How Soon We Forget*, E-LEARNING COUNCIL (June 5, 2010)

In his classic experiment, Ebbinghaus found that, beginning the moment after a person learns information, their ability to recall it decays.³⁹ For nonsense syllables, only twenty minutes later, the average user has a less-than-60% likelihood of recalling a given syllable.⁴⁰ An hour after learning it, it's less than 50%.⁴¹ A day later, they have lost nearly 70% of the information.⁴² At a month, the learner retains just 20% of the material they had learned.⁴³ Ebbinghaus found that the forgetting curve is, essentially, universal for given

³⁸ See EBBINGHAUS, *supra* note 31, at 77-78 (distilling the results of several experiments down to equations to map out the learning curve).

³⁹ See EBBINGHAUS, *supra* note 31, at 78 (calculating the increased memory loss as inverse to the amount of time passed).

⁴⁰ See EBBINGHAUS, *supra* note 31, at 79 (stating that after 18 minutes only 56% of information was retained by test subjects).

⁴¹ See snasta, *supra* note 36 (graphing memory retention after one hour at 44.2%).

⁴² See snasta, *supra* note 36 (estimating memory retention after one day at 33.7%).

⁴³ See snasta, *supra* note 36 (showing memory retention after one month at 21.1%).

subject matter, and the rate of memory decay differs little between individuals.⁴⁴

Ebbinghaus also showed that the curve demonstrates “exponential decay,” meaning that a large fraction of material learned is lost quickly.⁴⁵ However, even though the initial decline is steep, the rate of decay declines with time.⁴⁶ In the context of memory, this means that the longer a memory has been retained, the less likely it is to be lost for any future increment of additional time: material that “survives” becomes progressively less likely to be forgotten in each additional increment of time.⁴⁷ It also follows that if one wishes to remember information for the long term, the longer they are able to retain it in the initial stages of study the slower the information will decay.⁴⁸

For users of SR, this means that a few early review keeps many memories “alive” while still efficiently identifying those items that have inevitably been forgotten for restudy.⁴⁹ Success at early tests allows the interval to the next scheduled rehearsal to be expanded until they get onto the flatter bit of the curve.⁵⁰ The result is

⁴⁴ See ANNETTE TAYLOR, *ENCYCLOPEDIA OF HUMAN MEMORY* 488 (1st ed. 2013) (concluding that a generalized forgetting pattern existed among multiple subjects). The speed of decay does differ when certain variables are present, though whenever a given set of variables are present, the rate of decay is predictable. *Id.* Ebbinghaus showed the forgetting curve is steepest for nonsensical material and, in contrast, nearly flat for vivid or traumatic memories. *Id.* The speed of forgetting depends on a number of factors, including the difficulty of the learned material, how meaningful the material is to the subject, representation of material, and other physiological factors including stress and sleep. *Id.*

⁴⁵ See *id.* at 489 (noting that people forgot material learned three to six years after learning it in school).

⁴⁶ See *id.* (stating that the information remembered after the three to six year period is remembered for a lifetime).

⁴⁷ See Luke Mastin, *Long-Term Memory*, *THE HUMAN MEMORY* (2010), archived at <https://perma.cc/M5MT-VJAE> (describing how long-term memories can be retained almost indefinitely).

⁴⁸ See Luke Mastin, *Short-Term (Working) Memory*, *THE HUMAN MEMORY* (2010), archived at <https://perma.cc/Q93M-FT3P> (explaining the importance of motivation and effort in the conversion from short-term memories to long-term memories).

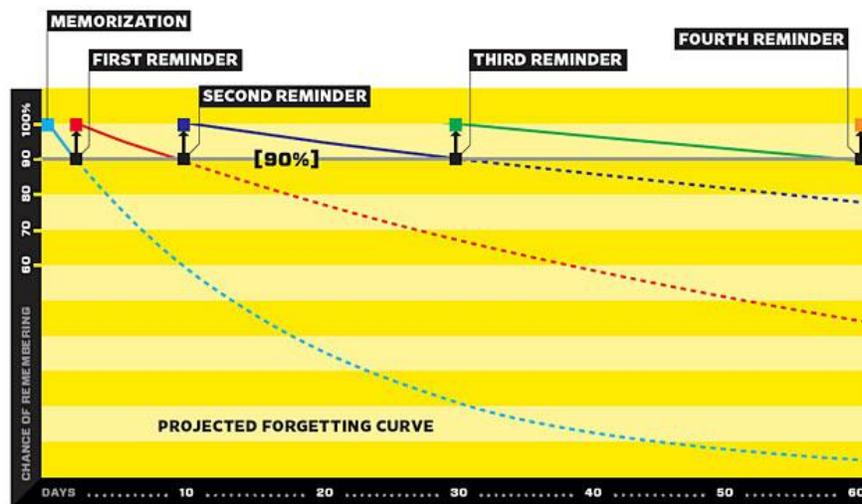
⁴⁹ See Wolf, *supra* note 35 (highlighting the learning method utilized by spaced repetition).

⁵⁰ See T. Landauer & R. Bjork, *Optimum Rehearsal Patterns and Name Learning*, *PRACTICAL ASPECTS OF MEMORY* 631 (M.M. Gruneberg, P.E. Morris, & R.N. Sykes eds. 1978) (detailing the results of one study showing how an expanding pattern is beneficial).

that the longer a memory has been retained, the less likely it is to be lost for any future increment of additional time.⁵¹

B. The Spacing Effect

The spacing effect is a corollary to the forgetting curve.⁵² This principle holds that properly spacing repetitions of studying *slows* the rate of memory decay, effectively adjusting the slope of the forgetting curve, thereby allowing longer periods to occur between review sessions.⁵³ The spacing effect increases over time, so that by the fourth and fifth reviews of a given piece of information, the increasing intervals between review sessions become pronounced, with the user no longer having to review after a few hours to not suffer a significant loss of information, but instead, only has to review again after several days or weeks.⁵⁴



⁵¹ See Mastin, *supra* note 47 (describing the physiology of long-term memory creation and how it strengthens synapses in the brain).

⁵² See Cepeda, *supra* note 31, at 1095 (connecting the forgetting curve to spaced repetition).

⁵³ See Cepeda, *supra* note 31, at 1101 (illustrating that too-short or too-long of a spaced repetition would not produce the same results as a properly spaced repetition).

⁵⁴ See Wolf, *supra* note 35 (providing an explanation of the data expressed in the graph).

Source: Gary Wolf, *Want to Remember Everything You'll Ever Learn? Surrender to This Algorithm*, WIRED (Apr. 21, 2008), archived at <https://perma.cc/BN4P-JR8W>.

This matters because it means that, by weathering the initial storm of studying on a SR algorithm a few times over a few days, users get the dividend of remembering information at a very high rate with little maintenance.⁵⁵ One could imagine that in law school, users would study a few times early in a semester, then have information essentially “banked” for the exam at semester’s end as a result of this phenomenon.⁵⁶ For that matter (and as detailed below in part V on using SR in legal education), a 1L could learn important information for their exams in Contracts or Civil Procedure, and, with very little maintenance after the first year, still remember nearly all of it for the bar exam more than 2 years later.⁵⁷

C. *The Testing Effect*

Finally, when people study using SR, they also benefit from the “testing effect,” which holds that people achieve recall of learned information more readily when they have tested themselves on it, as opposed to just passively observing it.⁵⁸ While testing without feedback improves learning and recall,⁵⁹ the effect is stronger when testing is associated with meaningful feedback by exposure to the correct answer.⁶⁰

⁵⁵ See Wolf, *supra* note 35 (articulating the importance of continued use in recalling memories).

⁵⁶ See Greg Gatlin, *Law Professor Develops Tech Tool that Boosts Student Learning*, SUFFOLK UNIV. NEWS & VOICES (Sept. 15, 2014), archived at <https://perma.cc/Q5V6-L4QX> (describing the advantages of spaced repetition for law students).

⁵⁷ See *id.* (explaining the benefits of studying for law school exams while using spaced repetition methods); see also *infra* Part V (outlining the ability for law students to recall information learned in their first year of law school years later).

⁵⁸ See Roediger & Karpicke, *supra* note 31, at 253 (illustrating the benefits of the “testing effect”); Gwern Branwen, *Spaced Repetition*, GWERN (Jan. 20, 2017), archived at <https://perma.cc/42B5-XM3E> (noting the basic principle of the spacing effect).

⁵⁹ See Roediger, *supra* note 7 (conveying that low-stakes quizzes throughout the semester improve retention of information).

⁶⁰ See Henry L. Roediger, III & Jeffrey D. Karpicke, *The Power of Testing Memory: Basic Research and Implications for Educational Practice*, 1(3) PERSP. PSYCHOL. SCI. 181, 191-92 (2006) (describing the ideal timing to provide students

Tests not only assess, but are also very positive and productive ways to reinforce learning and increase long-term retention.⁶¹ Studies have shown that self-testing a single time can be as effective in helping users retain information as passively reviewing information five times.⁶² In a separate study establishing the benefits of testing, a group of students were given varying routines of study *or* testing, or studying *and* testing.⁶³ A week later, the students who tested remembered 80% of the vocabulary, versus 35% for non-testing students.⁶⁴

with feedback). It is worth noting also that long term retention was improved when exposure to the correct answer followed a closed-book test versus an equivalent open-book test. *Id.* at 191-92 (portraying a study in which testing delays improved memory retention). *See also* Marlene Olde Bekkink et al., *Explicit Feedback to Enhance the Effect of an Interim Assessment: A Cross-Over Study on Learning Effect and Gender Difference*, 1 PERSP. MED. EDUC. 180, 187 (2012) (explaining the power of periodic feedback in enhancing learning).

⁶¹ *See* Steven M. Stahl et al., *Play it Again: The Master Psychopharmacology Program as an Example of Interval Learning in Bite-Sized Portions*, 15(8) CNS SPECTRUMS 358, 370 (2010) (citing Jeffrey D. Karpicke & Henry L. Roediger, III, *The Critical Importance of Retrieval for Learning*, 319 SCIENCE 966-68 (2003)) (examining the effects of self-assessment on memory formation); Benjamin C. Storm, Robert A. Bjork, & Jennifer C. Storm, *Optimizing Retrieval as a Learning Event: When and Why Expanding Retrieval Practice Enhances Long Term Retention*, 38 MEMORY & COGNITION 244, 244 (2010) (summarizing the positive gains of expanding the schedule of tests); Harold Pashler et al., *Enhancing Learning and Retarding Forgetting: Choices and Consequences*, 14(2) PSYCHONOMIC BULL. AND REV. 187, 190 (2007) (giving an overview of studies showing both delayed and immediate feedback provide benefits for learners); Bethany C. Johnson & Mark T. Kiviniemi, *The Effect of Online Chapter Quizzes on Exam Performance in an Undergraduate Social Psychology Course*, 36 TEACHING PSYCHOL. 33, 33-34 (2009) (advocating for the use of randomly administered quizzes and subsequent feedback in order to enhance student learning). *But see* David A. Cook, Warren G. Thompson et al., *Impact of Self-Assessment Questions and Learning Styles in Web-Based Learning: A Randomized, Controlled Crossover Trial*, 81 ACAD. MED. 231, 231 (2006) (displaying evidence that studies on self-assessment and feedback provide varying results).

⁶² *See* Branwen, *supra* note 58 (pointing to a study conducted by Gordon A. Allen, William A. Mahler, and W.K. Estes that shows strength in studying once actively compared to multiple passive sessions).

⁶³ *See* Branwen, *supra* note 58 (outlining the results of a study where students learned Swahili vocabulary).

⁶⁴ *See* Branwen, *supra* note 58 (providing the conclusion of a study in which students retained more by testing and studying the material).

Testing has proven a successful technique to aid in learning in multiple areas.⁶⁵ For example, in one study, medical residents' scores were higher when they tested themselves with questions, as opposed to just reviewing information.⁶⁶ On the GRE exam, testing as a tool to prepare has proven more effective for GRE preparation.⁶⁷ Similar results have been shown for using testing to learn material ranging from prose passages to scientific topics.⁶⁸

So, when users of SR review the content when prompted, they are benefiting from the testing effect by constantly forcing themselves to test what they have learned.⁶⁹ Understanding the underlying mechanisms of SR is not required to take advantage of this effect.⁷⁰ Nevertheless, recognizing the science at play behind the learning method is potentially motivating to users, both to help them approach the method with enthusiasm, and to trust in it.⁷¹

III. Research on the Effectiveness of SR

Put together, systems that leverage the forgetting curve, spacing effect and testing effect are called "spaced repetition systems."⁷² These systems have been built and studied in various contexts, in various disciplines, for decades.⁷³

The theoretical underpinnings for SR, and the richest experimental data to support, it come from simplified laboratory studies in

⁶⁵ See Bekkink, *supra* note 60, at 187 (implying that interim assessments have a positive effect on a final exam).

⁶⁶ See Branwen, *supra* note 58 (drawing a conclusion that question-based assessments have a higher impact on retention).

⁶⁷ See Branwen, *supra* note 58 (stating that GRE vocabulary cards benefited from the testing effect).

⁶⁸ See Branwen, *supra* note 58 (citing the Roediger/Karpicke and Pashler studies on subjects that benefitted from the testing techniques).

⁶⁹ See Roediger & Karpicke, *supra* note 60, at 192 (discussing the benefits of spaced retrieval techniques when used in conjunction with testing).

⁷⁰ See Roediger & Karpicke, *supra* note 60, at 192 (highlighting the benefits of the testing effect inherent in spaced repetition).

⁷¹ See Branwen, *supra* note 58 (summarizing spaced repetition's enhanced learning effects).

⁷² See Darren Edge et al., *MemReflex: Adaptive Flashcards for Mobile Microlearning*, MOBILEHCI 2012 CONF. ON HUMAN COMPUTER INTERACTION WITH MOBILE DEVICES & SERV. 431, 432 (2012) (discussing the overlap of the testing effect, spacing effect and forgetting curve).

⁷³ See *id.* (illustrating historical overview of spaced repetition system).

which subjects memorize random word lists, nonsense words, or random facts with short recall intervals.⁷⁴ These protocols were frequently used in an era before the advent of PCs and smart phones, so manual reminders (by a human) in a lab setting were the only feasible way to test SR's effectiveness.⁷⁵ Nonetheless, the research reflects that, among hundreds of studies, SR has proven more effective than cramming in nearly every instance and context.⁷⁶

A series of studies have also demonstrated SR to be useful for students understand complex and abstract information.⁷⁷ For example, in one experiment, a group of students training to take a high level biology course learned information at a significantly higher rate – and significantly faster – than with other methods.⁷⁸ Users also reported that using the method held attention better than other methods.⁷⁹ In another higher education-related experiment, 216 college students used SR to learn techniques to solve math problems.⁸⁰ The control group had crammed the knowledge of these methods, while the other group got the same total number of training/practice attempts, but used SR to learn them.⁸¹ The researchers found there was

⁷⁴ See Nicholas J. Cepeda et al., *Distributed Practice in Verbal Recall Tasks: A Review and Quantitative Synthesis*, 132 PSYCHOL. BULL. 354, 354 (2006) (observing memorization tests contributing to development of spaced repetition theory).

⁷⁵ See *id.* at 363 (demonstrating historical laboratory examinations on memory testing before the emergence of modern technology).

⁷⁶ See *id.* at 359 (noting the better results from spaced performance over massed performance); Donovan & Radosevich, *supra* note 3, at 795 (reaffirming the superiority of spaced practice conditions as compared to massed practice conditions).

⁷⁷ See Paul Kelley & Terry Watson, *Making long-term memories in minutes: a spaced learning pattern from memory research in education*, FRONTIERS IN HUM. NEUROSCIENCE, Sept. 25, 2013, at 1 (providing an example of a study of students using spaced repetition). Many SR studies involve relatively straightforward areas of learning, particularly matching words with definitions. *Id.*

⁷⁸ See *id.* at 6 (detailing one study where learning per hour of instruction was significantly higher for the spaced learning groups).

⁷⁹ See *id.* at 4 (indicating how one user commented that SR “was able to hold my attention the entire time, which was rather interesting as I can sometimes be distracted and lose concentration”).

⁸⁰ See Doug Rohrer & Kelli Taylor, *The Effects of Overlearning and Distributed Practise on the Retention of Mathematics Knowledge*, 20 APPLIED COGNITIVE PSYCHOL. 1209, 1209 (2006) (explaining briefly how two experiments were conducted testing the effect of overlearning on test scores).

⁸¹ See *id.* at 1213 (detailing the methodology of the initial experiment which divided students into “Spacers” and “Massers”).

an “extremely large” benefit for using spaced repetition versus cramming.⁸² Simply put, the students who spread out the same number of practice repetitions performed better in applying the mathematical principles they were preparing to be tested on.⁸³

SR has also been proven effective to help users *apply* complex content.⁸⁴ In one study, 38 surgical residents received five and a half hours of training in various surgical techniques.⁸⁵ One group received all of the practice time in one session; the other distributed the practice over four sessions.⁸⁶ Their total practice time was the same.⁸⁷ Thirty days after the final training session, each was actually asked to carry out the techniques they had learned.⁸⁸ Both groups improved, but the SR group outperformed the cramming group in key outcome measures (time, number of hand movements needed to perform a surgery, global ratings as defined by experts).⁸⁹

Perhaps of most direct relevance to legal education and law practice, SR has been proven effective in improving knowledge on other high-stakes standardized tests for students in professional fields.⁹⁰ For example, a study of over 1,000 medical students showed that those aided by SR in learning core curriculum knowledge had almost three times better recall on testing than those without it.⁹¹ The study also showed that SR proved helpful in identifying students in

⁸² See *id.* at 1209 (outlining the results of the study).

⁸³ See *id.* (reiterating that long term retention was boosted by spaced repetition versus overlearning).

⁸⁴ See Chris Loper, *Spaced Repetition*, NORTHWEST EDUC. SERV. (Jan. 4, 2016), archived at <https://perma.cc/4S6G-QRLD> (indicating how spaced repetition has been shown to improve skills more quickly than traditional practice regimes).

⁸⁵ See Carol-Ann E. Moulton et al., *Teaching Surgical Skills: What Kind of Practice Makes Perfect?*, 244 ANNALS OF SURGERY 400, 400 (2006) (describing a study that analyzed the benefits of spaced repetition learning in a non-traditional classroom setting).

⁸⁶ See *id.* (detailing the methodology of the experiment).

⁸⁷ See *id.* (indicating the constants in the experiment).

⁸⁸ See *id.* (providing that each resident returned to perform the microsurgical drill and a live rat anastomosis).

⁸⁹ See *id.* (describing the outcome of the experiment and showing how the distributed group was superior).

⁹⁰ See Kelley, *supra* note 77 (discussing the impact of spaced learned as measured for high-stakes standardized tests).

⁹¹ See Kerfoot et al., *supra* note 3, at 303 (discussing how SR is a “reliable, valid and diagnostically effective method to identify poorly performing students and to significantly improve students’ longer term retention of learning”).

need of extra support.⁹² The researcher behind this, B. Price Kerfoot of Harvard Medical School, has also established that SR can substantially improve knowledge of professional guidelines among current practitioners, as well as improve retention of core knowledge amongst medical students.⁹³ Working physicians (globally) and students (across institutions) showed high levels of acceptance of, and participation in, the learning games.⁹⁴

⁹² See Kerfoot et al., *supra* note 3, at 303 (indicating that spaced repetition learning was able to identify students at risk of performing below the median on their licensure examinations); see also B. Price Kerfoot et al., *Durable Improvements in Prostate Cancer Screening from Online Spaced Education: A Randomized Controlled Trial*, 39(5) AM. J. PREV. MED. 472, 472 (2010) (applying spaced education to prostate cancer research). Consider the study of continuing medical education that tracked the ability of SR training to improve prostate-cancer screening by 95 primary-care providers. *Id.* Participants using SR showed a 26% decrease in inappropriate cancer screenings on real-life patients, saving them money and minimizing patients' anxiety. *Id.* at 475-77. For practicing attorneys, SR also has promise to help them know more about their practice area, which, in turn may help with decision making on client matters. *Id.* at 477. There is no reason to think that SR does not have the potential to help attorneys better recall rules of evidence or case law in service of their clients. See also *Welcome to SeRious*, SERIOUS (2014), archived at <https://perma.cc/7SH6-YLYH> (applying the use of Spaced Repetition to legal education in order to better prepare future attorneys). Indeed, there is no reason to think that SR would not be helpful in aiding professionals in any number of fields to improve their long-term retention of important information for either testing situations or for ready-recall during the practice of their profession or trade. *Id.*

⁹³ See B. Price Kerfoot et al., *Online Spaced Education Generates Transfer and Improves Long-Term Retention of Diagnostic Skill: A Randomized Controlled Trial*, 211(3) J. AM. COLL. SURG. 331, 331 (2010) (explaining how online spaced education promotes long-term retention); B. Price Kerfoot, *Adaptive Spaced-Education Improves Learning Efficiency: A Randomized Controlled Trial*, 183(2) J. UROL. 678, 680 (2010) (highlighting the benefits of spaced repetition for both practitioners and students); Price Kerfoot et al., *supra* note 92, at 473 (explaining how spaced education boost learners' abilities to self-asses their performance); B. Price Kerfoot et al., *Interactive Spaced-Education to Assess and Improve Knowledge of Clinical Practice Guidelines: A Randomized Controlled Trial*, 249(5) ANN. SURG. 744, 747 (2009) (analyzing the effects of spaced repetition on medical learners); B. Price Kerfoot, *Learning Benefits of Online Spaced-Education Persist for 2 Years*, 181(6) J. UROL., 2671, 2672 (2009) (illustrating the improvement in test scores for spaced repetition cohorts).

⁹⁴ See Kerfoot et al., *supra* note 3, at 300 (describing how Kerfoot devised the spaced repetition tools and how easily adaptable it is for doctors and students to utilize).

In sum, the research has repeatedly shown that SR is a useful tool to improve learning and retention in nearly all areas of education.⁹⁵ From rote memorization to terms, to integrating concepts reinforced in SR to very complex fields, studies show promise to allow students to learn more, and learn it faster.⁹⁶ Improving platforms suggest that SR may prove to be even more effective as new technologies develop to give users easier, more efficient, access.⁹⁷

IV. Spaced Repetition Platforms

To benefit from SR, a user needs a platform that can show content and apply the SR algorithm.⁹⁸ What the platforms have in common is that they encourage the use of free recall (i.e. looking at a question and trying to define an answer), as opposed to methods that have proven less effective for creating durable memories.⁹⁹ They differ greatly, though, in the technology underlying them, ranging from manual systems to web-based tools that can be used on any device with sophisticated algorithms customized to each user.¹⁰⁰ This section explores platforms that have been created to date, and then lays out the aspects of the platform being built as part of this project, SpacedRepetition.com.¹⁰¹

⁹⁵ See Kerfoot et al., *supra* note 3, at 304 (explaining how Kerfoot’s digital SR tool can be used in areas of studies other than those pursuing their MD).

⁹⁶ See Benny Lewis, *Spaced Repetition: Never Forget Vocabulary Ever Again*, FLUENT IN 3 MONTHS (last visited Jan. 23, 2017), archived at <https://perma.cc/6HXT-K9XP> (illustrating the benefits to both rote memorization and spaced repetition).

⁹⁷ See Teresa Martín-Blas & Ana Serrano-Fernández, *The Role of New Technologies in the Learning Process: Moodle as a Teaching Tool in Physics*, 52 COMPUT. & EDUC. 35, 35 (2009) (illustrating that improving learning platforms with new technology will be effective and efficient for students).

⁹⁸ See Branwen, *supra* note 58 (highlighting specific individuals who have benefited from SR platforms).

⁹⁹ See Branwen, *supra* note 58 (asserting practices that create durable memories). In order of effectiveness, “research favors questions which force the user to use their memory as much as possible.” *Id.* This includes free recall, short answer questions, multiple-choice questions, Cloze deletion, and recognition. *Id.*

¹⁰⁰ Compare SERIOUS SOFTWARE FOR SERIOUS LAW STUDENTS, *supra* note 30 (showing a spaced repetition platform for law students); *Repetitions 1.82*, REPETITIONS (last visited Jan. 23, 2017), archived at <https://perma.cc/9PRR-YV28> (showing spaced repetition platform focused on improving general intelligence).

¹⁰¹ See *infra* Part IV A (comparing different SR platforms).

A. Analog SR Platforms

Before the digital age, there was no easy way to apply the research findings of SR.¹⁰² Instead, users had to be manually reminded when it was time to study – obviously, not feasible outside of controlled settings.¹⁰³ Then, nearly a half century ago, two low-tech implementations of SR were created to make it possible for personal use.¹⁰⁴

First, in 1967, Paul Pimsleur created a SR system to be used with audio language learning.¹⁰⁵ Users would be presented with a new vocabulary word to study, then would use a stopwatch along with audio instruction to cue themselves to recall information with precise timings.¹⁰⁶ Pimsleur's initial intervals expanded by 5 with each repetition: students were expected to use a stopwatch to help themselves review a given piece of material 5 seconds, 25 seconds, 2 minutes, 10 minutes, 1 hour, 5 hours, 1 day, 5 days, 25 days, 4 months, and 2 years after initially learning it.¹⁰⁷

Six years later, in 1973, Sebastian Leitner created a SR system using the "Leitner Box."¹⁰⁸ The Leitner Box uses a box with several compartments and physical flashcards.¹⁰⁹ Users create flash-

¹⁰² See *Spaced Repetition*, WORLD HERITAGE ENCYCLOPEDIA (last visited Jan. 23, 2017), archived at <https://perma.cc/VL8G-PCA8> (describing how advancements in technology benefited reporting spaced repetition research).

¹⁰³ See *id.* (increasing technology allows individuals to learn more information more efficiently).

¹⁰⁴ See *id.* (introducing practical application of spaced repetition theory); Dan LaSota, *Effective Learning: Spaced Repetition Systems*, in TEACHING TIPS 6 (Univ. Alaska Fairbanks, 2015) (setting forth Sebastian Leitner's 1970's spaced repetition system).

¹⁰⁵ See Paul Pimsleur, *A Memory Schedule*, 51(2) MOD. LANGUAGE J. 73 (1967) (pointing to a schedule as a key requirement for teachers to allow their students to retain information).

¹⁰⁶ See *id.* at 75 (explaining the difference in timing for learning terms based on the complexity of the word itself).

¹⁰⁷ See *id.* (showcasing how he Pimsleur used standard intervals to show the probability of remembering).

¹⁰⁸ See *Spaced Repetition*, *supra* note 102 (introducing the Sebastian Leitner System of flashcards).

¹⁰⁹ See *Spaced Repetition*, *supra* note 102 (describing the process of Leitner box flashcard system).

cards, then test themselves to recall the solution written on a flashcard.¹¹⁰ If the user succeeds, the flashcard advances to the next compartment.¹¹¹ But if the user fails, the card goes back one step to the previous compartment.¹¹² Each succeeding group has a longer period of time before the user is required to review the cards.¹¹³ The method suffers the predictable failing when a user attempts to keep hundreds or thousands of newly learned pieces of information available for using on the SR schedule: it's just too much to track.¹¹⁴

B. Digital SR Platforms

These two analog methods to employ SR are both labor-intensive and limited to applying only simple algorithms.¹¹⁵ However, with the development of personal computers in the 1980s, SR's potential grew, as SR began to be implemented with software-based solutions.¹¹⁶ These systems are both more convenient (no need for a timer, a box, or content written on index cards), and more effective.¹¹⁷

Computer-based implementations of SR allow for better results because modern algorithms can specifically adapt to users.¹¹⁸

¹¹⁰ See Robert Harris, *Learning Strategy 10: The Leitner Flash Card System*, VIRTUALSALT (Feb. 27, 2014), archived at <https://perma.cc/NA2G-4FF8> (explaining the method of the Leitner System as a progressive system of re-examining flashcards to see if the user has truly memorized the information).

¹¹¹ See *id.* (demonstrating how the software advances based on individualized answers).

¹¹² See *id.* (providing the method implemented by the Leitner System).

¹¹³ See *id.* (illustrating the frequency of review for each box).

¹¹⁴ See *What is Spaced Repetition?*, *supra* note 15 (pointing to potential shortcomings of the Leitner System).

¹¹⁵ See *Spaced Repetition*, *supra* note 102 (identifying the inefficiencies of traditional, manual SR methods).

¹¹⁶ See Joel Santo Domingo, *30 Years of the PC: A Timeline*, PC MAGAZINE (Aug. 12, 2011), archived at <https://perma.cc/4Z34-LB4H> (discussing the rise in popularity of the PC in the 1980s); see also Damien Elmes, *About Anki*, ANKI (last visited Jan. 23, 2017), archived at <https://perma.cc/LV3G-AYNF> (illustrating the effect of increased efficiency of digital study programs driven by technological advances).

¹¹⁷ See Elmes, *supra* note 116 (describing the efficiency of digital studying techniques).

¹¹⁸ See Philip Seifi, *Want to recall 92% of everything you learn? This algorithm makes forgetting difficult*, LINGUALIFT (last visited Jan. 24, 2017), archived at <https://perma.cc/8ADK-PHGA> (explaining how computer algorithms adapt to a person's retention level).

Rather than just using a time-interval between reviews, they can ask the user to rate their ability to answer a question posed to them.¹¹⁹ A higher scored answer (indicating the user knew it very well) prompts the algorithm to not repeat the card as close in time as would a lower-scored card.¹²⁰ This improvement allows for individual customization in a way that was previously unimaginable.¹²¹

Computerized implementations of SR also allow for technology to be employed in ways physical flashcards cannot.¹²² Online cards can include features like audio files or a “third side” (additional information to supplement the question/answer of the typical flashcard).¹²³ They also make things that are hard with physical flashcards easy: they can be easily shared, edited, copied, imported/exported, and re-grouped for studying.¹²⁴

By implementing machine learning, material that is hard appears more often and material that is easy less often, with difficulty defined according to the ease with which the user is able to produce a correct response.¹²⁵

Early implementations, like Anki¹²⁶ and Mnemosyne,¹²⁷ were created as software downloads – programs tethered to specific computers.¹²⁸ They favor sophisticated computer users (for example, Mnemosyne is packaged for Ubuntu Linux operating system users;

¹¹⁹ See *What is Spaced Repetition?*, *supra* note 15 (referring to how users are able to rate a questions difficulty level in addition to the space repetition process).

¹²⁰ See *What is Spaced Repetition?*, *supra* note 15 (optimizing card efficiency).

¹²¹ See *What is Spaced Repetition?*, *supra* note 15 (customizing cards therefore automatically managing learning).

¹²² See K.M. Lawson, *Anki All the Way*, FOOL’S FLASHCARD REVIEW (July 9, 2009), archived at <https://perma.cc/RS73-TG9N> (highlighting technological advances in online flashcards as opposed to physical flashcards).

¹²³ See *id.* (noting the function of the third side when using online flashcards).

¹²⁴ See *id.* (allowing users to quickly and easily adapt their online flashcards).

¹²⁵ See *What is Spaced Repetition?*, *supra* note 15 (adapting different levels of material therefore more difficult material appears more often).

¹²⁶ See Elmes, *supra* note 116 (indicating that the web version, download, and iPhone app are all paid-access only).

¹²⁷ See *Welcome to the Mnemosyne Project*, THE MNEMOSYNE PROJECT (last visited Jan. 24, 2017), archived at <https://perma.cc/K9XN-2RRA> (describing the basics of the Mnemosyne Project).

¹²⁸ See Elmes, *supra* note 116 (describing how the software installs to a fixed computer).

an OS system that has been largely adopted by skilled computer programmers, but few others).¹²⁹ Then, in the early 2000s, various Web 1.0 solutions arose to applying the spaced repetition algorithm online.¹³⁰ Unfortunately, many have flaws: a poor algorithm that reduced the benefits of SR, bug-filled, expensive, and so on.¹³¹ Others allow for some tantalizing features, but have limitations that make their widespread use unappealing.¹³² In the past several years, various tools have been built, and Wikipedia maintains a robust list of SR projects, together with a chart identifying features of each.¹³³

Among the most exciting was the SuperMemo project by Piotr Wozniak.¹³⁴ Wozniak, a Polish scientist, has studied optimization of SR algorithms for two decades.¹³⁵ As part of his work, he has open-sourced algorithms, so that savvy computer programmers can implement his research into their own software platform.¹³⁶

¹²⁹ See *Documentation*, THE MNEMOSYNE PROJECT (last visited Jan. 24, 2017), archived at <https://perma.cc/HP9P-AVUE> (referencing compatibility with Linux operating system); see also Danny Stieben, *6 Superb Reasons Why You Should Use Linux for Programing*, MAKEUSEOF (Oct. 28, 2014), archived at <https://perma.cc/6MMD-3GKK> (highlighting adoption of Linux by skilled computer programmers).

¹³⁰ See *Site Review: Flashcard Exchange*, EDUCATION WORLD (2009), archived at <https://perma.cc/9RVG-X7RR> (reviewing early spaced repetition website, Flashcard Exchange founded in 2001); see also Liz Karagianis, *Quiz Yourself*, SPECTRUM (2009), archived at <https://perma.cc/ML3V-S3SN> (profiling the software behind popular online application called “Quizlet” which was launched in 2007).

¹³¹ See Karagianis, *supra* note 130 (illustrating the immense time and resources required to build a program suitable for launch).

¹³² See Shellenbarger, *supra* note 8 (outlining the different features for flashcard software utilizing spaced repetition).

¹³³ See *List of Flashcard Software*, WIKIPEDIA (last visited Jan. 24, 2017), archived at <https://perma.cc/ZH34-RTD3> (listing different spaced repetition software programs available on the market and articulating different features of each spaced repetition program available).

¹³⁴ See Wolf, *supra* note 35 (discussing the algorithm that led to Wozniak’s creation of SuperMemo).

¹³⁵ See Wolf, *supra* note 35 (highlighting Wozniak’s research in the field of spaced repetition).

¹³⁶ See Piotr Wozniak, *Repetition spacing algorithm used in SuperMemo 2002 through SuperMemo 2006*, SUPERMEMO (Jan. 2005), archived at <https://perma.cc/XJA9-ZTK4> (publishing the algorithm behind the SuperMemo software).

C. *SpacedRepetition.com: a SR Platform for a Mobile Generation*

I predict that SR will reach its full potential, along with widespread acceptance, with the creation of SR tools for a mobile-first generation.¹³⁷ Nearly every young adult in America has a smartphone.¹³⁸ These machines have more computing power than was necessary to put a human on the moon (in fact, the iPhone 6 can carry out instructions 120 million times faster than the computers on the Apollo)¹³⁹ and give coders the ability to create remarkably powerful algorithms to maximize efficiency of an SR.¹⁴⁰ Further, smart phones have the ability to access the web using wireless data, give students an ability never before seen to learn anywhere, all on a machine they keep in their pockets.¹⁴¹

To do my part, I have spent the past several years building SpacedRepetition.com. This project is intended to, ultimately, be a free tool for law students, bar preppers, and other legal professionals to use.¹⁴² The features of the platform are themselves important,

¹³⁷ See Lewis, *supra* note 96 (recognizing that mobile devices allow for easier adoption of spaced repetition programs). This is not to say the software should not also work on laptop and desktop computers. *Id.* One of the benefits of building for the web is that the programs will run on any machine that can access the Internet. *Id.*

¹³⁸ See Aaron Smith et al., *U.S. Smartphone Use in 2015*, PEW RESEARCH CENTER (Apr. 1, 2015), *archived at* <https://perma.cc/6YWG-PB2N> (revealing a 2015 study where 85% of Americans between ages 18-29 have a smart phone). It is likely that the figure is significantly higher among those in law school and law practice. *Id.*

¹³⁹ See Tibi Puiu, *Your Smartphone is Millions of Times More Powerful than all of NASA's Combined Computing in 1969*, ZME SCIENCE (Oct. 13, 2015), *archived at* <https://perma.cc/4BP9-2HUK> (illustrating the computing power of an iPhone compared to NASA computers in the 1960s).

¹⁴⁰ See *id.* (recognizing the immense computer power available to coders today).

¹⁴¹ See Smith, *supra* note 138 (emphasizing the importance of smartphones in maintaining access to online information).

¹⁴² See SERIOUS SOFTWARE FOR SERIOUS LAW STUDENTS, *supra* note 30 (describing the SeRiouS tool available for free download); see also *New Feature: Invite Others to Co-Own or View Sets*, SERIOUS (last visited Jan. 25, 2017), *archived at* <https://perma.cc/T5FY-KFU3> (describing the goal as a site free for users, with upkeep for the site and server costs paid through grants and/or academic institutions). Until funding is secured, costs will be kept as low as possible for users. *Id.*

too.¹⁴³ Some key aspects built into SpacedRepetition.com based on the advice of hundreds of beta testers who used the site are to:

- Make it Web-based. Early efforts to make computerized SR were software downloads – i.e. they required saving a program to a computer’s hard drive and were used only on that computer.¹⁴⁴ Given the growth of processing power in smart phones, and the speed at which the web can process sophisticated apps, the newest versions of SR tools should be web-based, thus allowing for more portability.¹⁴⁵ This will work anywhere there is a web connection and not tether a user to a specific device.¹⁴⁶
- Build it using Responsive Design Principles. Making a tool easy-to-use will improve compliance for users to complete their daily sessions.¹⁴⁷ Optimally, users should be able to use their SR tool anywhere they are: home, school, a coffee shop, or while sitting on a bus.¹⁴⁸ This is feasible using responsive design, which is a method that allows websites to automatically re-format themselves to be easily accessed on smart phones, laptops, and desktops.¹⁴⁹ As long as there is web

¹⁴³ See SERIOUS SOFTWARE FOR SERIOUS LAW STUDENTS, *supra* note 30 (providing the methods used by the SeRiouS platform and how they work).

¹⁴⁴ See Chen & Teng, *The design and development of a computerized tool support for conducting senior projects in software engineering education*, 56 COMPUT. & EDUC. 802, 802 (2011) (presenting different approaches in computerized tool support).

¹⁴⁵ See *SeRiouS as an iPhone App!*, SERIOUS (Jan. 2016), *archived at* <https://perma.cc/M73R-BD9Q> (extolling the benefits of having the ability to use SeRiouS in a portable manner).

¹⁴⁶ See *id.* (explaining that anyone who uses the SeRiouS iPhone app can use the services at any location where they can connect to the Internet).

¹⁴⁷ See *Welcome to SeRiouS*, SERIOUS (last visited Jan. 25, 2017), *archived at* <https://perma.cc/7SH6-YLYH> (highlighting the convenience of having a spaced repetition app on a smartphone, PC, or Mac).

¹⁴⁸ See *id.* (illustrating how the spaced repetition smartphone app allows a user to study anywhere they choose).

¹⁴⁹ See *The New Design Trend: Build a Website; Enable Self-optimization Across All Mobile Devices*, RAPIDVALUE (last visited Jan. 25, 2017), *archived at* <https://perma.cc/442Z-UCDD> (defining responsive web design).

access, this allows users of SR to study at a desktop computer, laptop computer, or smart phone; or toggle between them.¹⁵⁰ Even more so, it allows users to do all of this seamlessly, regardless of whether their computer is a Mac or a PC, or whether their smart phone is an iPhone or a Droid.¹⁵¹ For those who want to treat the tool as an app, the site should have an icon available for those who bookmark it to their smartphone, giving the site the feel of an app (i.e. the user would click on the icon to access the tool, just as he or she would for any other app on the phone).¹⁵² However, instead of running off of native software built specifically for iPhone or Droid, the program runs on the web.¹⁵³

- Use the best algorithm, even if it's hard to implement. The platform should incorporate the most sophisticated algorithm for applying SR.¹⁵⁴ Currently, the open-source algorithm, "Super-Memo 2" allows users to retain 92% of what they learn.¹⁵⁵

¹⁵⁰ See *id.* (explaining how responsive web design works and can be used between devices); see also SERIOUS SOFTWARE FOR SERIOUS LAW STUDENTS, *supra* note 30 (stating "all you need is internet!").

¹⁵¹ See *The New Design Trend: Build a Website; Enable Self-optimization Across All Mobile Devices*, *supra* note 149 (describing the ability to transfer between devices, regardless of the brand).

¹⁵² See *The New Design Trend: Build a Website; Enable Self-optimization Across All Mobile Devices*, *supra* note 149 (depicting the optimization of user experience of an app across devices).

¹⁵³ See *The New Design Trend: Build a Website; Enable Self-optimization Across All Mobile Devices*, *supra* note 149 (comparing the number of versions required for mobile web apps as opposed to responsive web design).

¹⁵⁴ See Robert Godwin-Jones, *From Memory Palaces to Spacing Algorithms: Approaches to Second-Language Vocabulary Learning*, 14(2) LANGUAGE LEARNING & TECHNOLOGY 4, 7 (2010) (describing SuperMemo's advanced programming).

¹⁵⁵ See Piotr Wozniak, *Further improvement of SuperMemo: introduction of the matrix of optimal factors*, SUPERMEMO (Sept. 17, 1998), archived at <https://perma.cc/T24X-HZ6M> (analyzing results of SuperMemo 2, SuperMemo 4, and SuperMemo 5 which has a 92% retention rating after 190 days); see also Wozniak, *supra* note 136 (documenting previous versions of SuperMemo). Some versions allow for review of cards individually or by group based on the difficulty of categories. *Id.* Nonetheless, creators of SR tools should continually look out for improvements to the algorithms available to help improve users' retention. *Id.*

The algorithm is freely available for implementation for coders with the talent to do so.¹⁵⁶

- Have experts create core content. Content should be shareable.¹⁵⁷ For example, if an expert in a topic is willing to create cards and share them as a single deck, the system should allow for this.¹⁵⁸ Doing so helps to prevent a risk of using SR: that it teaches one to learn effectively, but if the content is bad, users will know bad information.¹⁵⁹ Junk goes in, junk comes out.¹⁶⁰ Instead, one can imagine that a professor could review a draft of cards made by a TA, confirm their accuracy, and then encourage the class to use them as a whole.¹⁶¹ The benefit would be that students would all be studying correct, vetted information, without the need to buy canned supplements.¹⁶² It would also promote creative collaboration between all students in a given course using SR; or smaller study groups that want to collaborate.¹⁶³

¹⁵⁶ See Piotr Wozniak, *SuperMemo 2 Plug-In for SuperMemo for Window: Delphi source code*, SUPERMEMO (last visited Jan. 25, 2017), archived at <https://perma.cc/6UW6-GHGC> (describing SuperMemo 2 algorithm and research on its efficacy).

¹⁵⁷ See Alcino Ferreira, *Rapid-Learning and IT tools for Teaching and Learning Maritime English*, 27 INT'L MAR. ENG. CONF. 73, 75 (noting Anki software allows users to share decks between devices).

¹⁵⁸ See *id.* (pointing to the useful sharing feature in Anki memorization software).

¹⁵⁹ See Chris Nickson, *Learning by Spaced Repetition*, LIFE IN THE FASTLANE (last visited Jan. 25, 2017), archived at <https://perma.cc/9AKN-TZDU> (recognizing the risk of learning incorrect material if using inaccurate decks compiled by other users).

¹⁶⁰ See *id.* (emphasizing the need to have correct answers in order to learn correct information).

¹⁶¹ See *id.* (discussing the general process of creating and sharing flashcards for spaced repetition learning); see also *Welcome to SeRiouS*, *supra* note 147 (stating that professors can also create cards for students to use).

¹⁶² See *Welcome to SeRiouS*, *supra* note 147 (explaining the importance of understanding the information before beginning to use spaced repetition).

¹⁶³ See *Welcome to SeRiouS*, *supra* note 147 (describing the ways law students can create spaced repetition flashcards together).

- Editable. Users should be able to easily create and edit content, preferably with others.¹⁶⁴ As users study and discover their weaknesses, it is important that they are able to add cards to decks, as well as edit those within it.¹⁶⁵ For people studying in groups, it's vital to allow for feedback to be shared among them.¹⁶⁶
- Provide a Third Side Option. Flashcards should be capable of providing an associated "tip" that's neither on the front nor back of the card.¹⁶⁷ This "third side" would allow users to, for example, test their knowledge of a piece of black letter law, then give them a tip about the context in which it is most likely tested.¹⁶⁸
- Users choose to share (or not). The optimal SR system will allow users to make content public, private or share with limited others.¹⁶⁹ People creating study materials should have the autonomy to share with others, or not.¹⁷⁰ There are immediate benefits to sharing (like the ability to have others provide feedback and edits, as well as to divide up the work), but disadvantages, too (in a competitive

¹⁶⁴ See Olle Linge, *Why manually adding and editing flashcards is good for you*, HACKING CHINESE (Aug. 23, 2013), archived at <https://perma.cc/33DF-EMY7> (recognizing the importance of creating and editing flashcards in conjunction with spaced repetition programs).

¹⁶⁵ See *id.* (acknowledging the benefit of adding information to flashcards as time passes).

¹⁶⁶ See *What are the benefits of group work?*, CARNEGIE MELLON UNIV. (2015), archived at <https://perma.cc/R4VH-WW24> (highlighting the importance of feedback in study group success).

¹⁶⁷ See Todd Scacewater, *Keep Your Greek: Don't Lose Your Vocabulary*, EXEGETICAL TOOLS (Aug. 5, 2015), archived at <https://perma.cc/69SL-L4F3> (providing an example of flashcards with a "third side" containing a mnemonic device).

¹⁶⁸ See *id.* (showing an example of a real flashcard application that utilizes the "third side").

¹⁶⁹ See *New Feature: Invite Others to Co-Own or View Sets*, *supra* note 142 (detailing one flashcard program's ability to specify privacy settings, allowing them to add, edit, or delete cards in the stack).

¹⁷⁰ See *New Feature: Invite Others to Co-Own or View Sets*, *supra* note 142 (illustrating some students have different preferences in how they share information).

course, helping others achieve more makes the curve harder to surmount).¹⁷¹ So, users should simply be given the option of making their content private, sharing only with designated others (like a study group), or making them totally open for all.¹⁷² Hybrid approaches could work, too, such as agreeing with users to keep content private for the academic year, but then making it public.¹⁷³ Creating a high quality, deep database of content factors into the next feature (crowdsourcing).¹⁷⁴

- Crowdsource. Curate a crowdsourced database of SR public cards, sortable by relevant grouping.¹⁷⁵ This would allow users to share cards by school, professor and course (or by bar topic and state of testing).¹⁷⁶ Subsequent users would then be able to access this content customized to their own specific needs and improve it based on their own understanding of the law.¹⁷⁷

¹⁷¹ See *Using Study Groups*, EDUCATION CORNER (last visited Jan. 25, 2017), archived at <https://perma.cc/K3B4-C63H> (listing the numerous benefits of studying in groups such as improving notes, providing insight, and dividing up material); Evan Jones, *How Do Law School Grades Work?*, LAWSCHOOLI (last visited Feb. 14, 2017), archived at <https://perma.cc/C2XQ-W6QA> (describing a typical law school's grading curve where students' performance is compared to that of everyone in the class).

¹⁷² See *New Feature: Invite Others to Co-Own or View Sets*, *supra* note 142 (highlighting that based on the various advantages and disadvantages of group study, students should be able to pick and choose who they share their content with).

¹⁷³ See Joe Mornin, *Fixing The Law School Grading Curve*, JOE MORNIN (Mar. 31, 2013), archived at <https://perma.cc/YP8K-HGDA> (acknowledging the law school grading curve discourages collaboration). Mornin argues that by eliminating the need for competition, however, students will be more likely to share their knowledge, content, materials, and so forth. *Id.*

¹⁷⁴ See *New Feature: Invite Others to Co-Own or View Sets*, *supra* note 142 (reaffirming the program's ability to create a collection of quality information).

¹⁷⁵ See *New Feature: Invite Others to Co-Own or View Sets*, *supra* note 142 (indicating the goal of creating groups of cards specific to courses, professors, or subjects).

¹⁷⁶ See *New Feature: Invite Others to Co-Own or View Sets*, *supra* note 142 (explaining the options that can be used for creating flashcards).

¹⁷⁷ See *How Cutting Edge #LegalTech Can Help Law Students Perform Better on Course Exams and the Bar*, SERIOUS (last visited Jan. 26, 2017), archived at <https://perma.cc/XX9V-JTS4> (highlighting the ability of card decks to be used for a variety of different test subjects).

- Easy Upload. For users to create lots of content, it is vital that it is easy for them to move from platform to platform.¹⁷⁸ Designing a system that could accept, for example, bulk uploads from .csv files (the generic version of an Excel Spreadsheet), would increase ease of use and promote participation.¹⁷⁹
- Reports for Designated Administrators. If SR is to be used by a group of students, giving their professor the ability to confirm that users are doing their daily work would be beneficial to promote compliance, as well as to help the professor flag students having difficulty.¹⁸⁰ A simple system to create weekly class reports would be a useful way of doing so.¹⁸¹ This report should include the name of the user, the last time logged on, the number of cards reviewed, and whether the user has met their daily quota during the reporting period.¹⁸²

¹⁷⁸ See *Moving data across platforms – file format considerations*, IBM KNOWLEDGE CENTER (last visited Jan. 26, 2017), archived at <https://perma.cc/ACZ2-6HFU> (stating the importance of being able to transfer data between different platforms).

¹⁷⁹ See *The World's Smartest Flashcards*, BRAINSCAPE (last visited Jan. 26, 2017), archived at <https://perma.cc/BDP7-GJAB> (using an example of one spaced repetition program's use of bulk import to facilitate the user's interaction with the program).

¹⁸⁰ See Shellenbarger, *supra* note 8 (offering an example of a spaced repetition program that can be used in classrooms to customize lessons based on students' comprehension); see also Tanagrabeast, *A Year of Spaced Repetition Software in the Classroom*, LESSWRONG (Jul. 4, 2015), archived at <https://perma.cc/TA9T-LCUL> (illustrating that classroom use is only beneficial if done by a group effort as opposed to individual use). Of course, this would only be in situations where an entire community subscribed at the school's expense. *Id.* Individual users, creating their own accounts, should not be subject to oversight from their professors and deans unless they opt to have that oversight. *Id.*

¹⁸¹ See Will Thalheimer, *Spacing Learning Over Time*, WORK-LEARNING RESEARCH, INC. (Mar. 2006), archived at <https://perma.cc/AHM9-L4B7> (noting that by providing feedback to the learners' manager, it is easier to implement different strategies to promote learning).

¹⁸² See *Formative Assessment System: User's Guide for Law Professors*, BARBRI 8 (last visited Feb. 15, 2017), archived at <https://perma.cc/5HF7-VBNR> (listing the important information to be included in the results report). The report, though, should probably not include the score the student gave themselves for their

- **Support it.** Like all good web-based tools, the system must also have good support, too.¹⁸³ That means it would include educational materials to give users a perspective on why what they are doing matters.¹⁸⁴ Taking a metacognitive approach to explain the science behind the system would likely motivate users in a way that just thinking of the system as web-based flashcards would not.¹⁸⁵ Further, to encourage things like effective collaborative card-creation for a class, the system should provide information and instructions on how to do so.¹⁸⁶
- **Improve it.** Finally, as technologies improve and users give feedback, the project should work to give users the best possible learning experience.¹⁸⁷ To do so requires an open flow of feedback between user and designer, as well as use of tools, like online surveys, to determine what is, and is

knowledge on the card. *Id.* (omitting individual student evaluations). See Daniel J. Hotard, *The effects of self-assessment on student learning of mathematics 7* (2010) (unpublished M.S. thesis, Louisiana State University) (on file with Electronic Thesis and Dissertation Library, Louisiana State University), *archived at* <https://perma.cc/M8RM-LPTD> (suggesting the need for proper teacher instruction for student evaluations because there is a risk students would over-rate their knowledge to try to impress their teachers, which is counter-productive to the algorithm most effectively scheduling study sessions).

¹⁸³ See Matthew Guay, *The 20 Best Help Desk Apps and Knowledge Base Tools for Customer Support*, ZAPIER (last visited Jan. 26, 2017), *archived at* <https://perma.cc/5AAR-8WR8> (explaining why customer support tools are critical to the success of the web-based tool).

¹⁸⁴ See *id.* (demonstrating the importance of making product documentation available for customers upfront).

¹⁸⁵ See Kanesa D. Seraphin et al., *Metacognition as Means to Increase the Effectiveness of Inquiry-based Science Education*, 23 SCI. EDUC. INT'L 366, 368 (2012) (noting how applying metacognitive principles can enhance a student's self-learning ability).

¹⁸⁶ See *id.* (discussing the benefits of metacognitive skills and how they improve student understanding of the science or technology). Best practices might include, for example, making sure that students work in groups and that multiple users help edit cards. *Id.* at 376. It might also include creating a clear method for dividing up responsibilities for which users are to cover various parts of the syllabus. *Id.*

¹⁸⁷ See Guay, *supra* note 183 (recommending creation of a forum for users to provide ideas and tips to improve the platform).

not working for users.¹⁸⁸ Additionally, collecting data (with appropriate permissions from users) would allow for seeing what variables improve outcomes for users – the ultimate test of the SR platform is, of course, whether or not it helps users learn and remember the desired material.¹⁸⁹

V. SR's Place in Legal Education and Law Practice

The notion that spaced repetition could be used for improving classroom learning was first proposed in the book *Psychology of Study* by Prof. C. A. Mace in 1932.¹⁹⁰ To date, more than 80 years later, no effort has been made to apply the methodology to better learning for law students.¹⁹¹ This should change, because SR is a nearly perfect match with the study of law.¹⁹² To be a successful lawyer (or law student), one must know thousands of bits of information: fine points of statutes, rules of procedure and evidence, important cases' holdings and their broader implications.¹⁹³ To commit

¹⁸⁸ See Chris Gray, *Better User Research Through Surveys*, UX MASTERY (Nov. 20, 2014), archived at <https://perma.cc/M7U6-6BG8> (identifying reasons to utilize surveys from users to assess the quality of the web tool).

¹⁸⁹ See Kevin White, *Data Collection is Shaping Brand Perception – How to Improve Your Reputation*, GIGYA (last visited Jan. 26, 2017), archived at <https://perma.cc/85QT-HEJQ> (recognizing the value of harnessing user data to evaluate the effectiveness of the SR platform).

¹⁹⁰ See C.A. MACE, *THE PSYCHOLOGY OF STUDY*, 38-39 (1932) (referencing historical approaches to learning through spaced repetition). “Perhaps the most important discoveries are those which relate to the appropriate distribution of the periods of study . . . Acts of revision should be spaced in gradually increasing intervals, roughly intervals of one day, two days, four days, eight days, and so on.” *Id.*

¹⁹¹ See *id.* (commenting on the length of time since publication and lack of application to law study context).

¹⁹² See SERIOUS SOFTWARE FOR SERIOUS LAW STUDENTS, *supra* note 30 (proclaiming the benefit of SeRiouS for law school students).

¹⁹³ See Sofia Gymer, *7 qualities every good lawyer should have*, ALLABOUTLAW (last visited Jan. 26, 2017), archived at <https://perma.cc/7F6K-GC9X> (highlighting the analytical, research and judgment skills you need to be a successful lawyer).

this to long-term memory requires reinforcement of the information.¹⁹⁴ This is not just a challenge for students, either: legal professionals are *constant* learners, from the first day of 1L, to the day they retire, they are always learning and while sometimes the options exists to simply look up the missing facts, there are many situations where the efficacy of expert practice depends on the ability hold this body of substantive knowledge available for recall at will.¹⁹⁵

SR is particularly well adapted to law students because of shortcomings in traditional legal education.¹⁹⁶ Modern law students are largely left on their own to retain information that they have read and briefly touched on in class.¹⁹⁷ Some of the common methods, like encouraging outlining throughout the semester, might function to improve memorization.¹⁹⁸ However, there's no "smart" technology mechanism in place to help students do this learning.¹⁹⁹ The opportunity available by using SR becomes even more significant because of the quirk in legal education: the core, bar-tested content (courses like Constitutional Law, Contracts, Civil Procedure, Criminal Law/Procedure, Evidence, Real Property and Torts) typically take place in the first year, but then are not tested during the second or

¹⁹⁴ See Jon Simons, *How to maximise your memory*, GUARDIAN (Jan. 13, 2012), archived at <https://perma.cc/L4JR-QGYJ> (explaining how students rehearse information to retain it in their short-term memory and transfer it into long-term memory).

¹⁹⁵ See Anthony S. Niedwiecki, *Lawyers and Learning: A Metacognitive Approach to Legal Education*, 13 WIDENER L. REV. 33, 33-34 (2006) (summarizing the manner in which law students learn).

¹⁹⁶ See *id.* at 34-35 (highlighting the potential shortcomings in traditional legal education and how law school classrooms are being adapted to meet every learning style).

¹⁹⁷ See *id.* at 34 (indicating that there is "implicit teaching" in law school leaving students to resort back to mimicking what they have seen in class).

¹⁹⁸ See *How to Study More Effectively – Top Methods for College*, DISCOVER BUSINESS (last visited Jan. 29, 2017), archived at <https://perma.cc/C3H9-5NUP> (discussing the benefits and shortcomings of outlining). It is hard to say for certain, simply because so little has been done to empirically test how law students learn best and what methods are most effective to help prepare them for the bar exam and legal careers. See also Leah M. Christensen, *Legal Reading and Success in Law School: An Empirical Study*, 30 SEATTLE U. L. REV. 603, 603 (2007) (pointing out the lack of research about how law students study best).

¹⁹⁹ See *How to Study More Effectively – Top Methods for College*, *supra* note 198 (highlighting that current technology can only improve upon a student's basic study methods).

third.²⁰⁰ By implementing SR, the work students would do to prepare for 1L exams could prepare them for the bar (the spacing effect dictates that by studying as 1Ls, SR users would barely have to review at all as 2L or 3Ls to have most of the information “banked” for the bar exam).²⁰¹

Yet, there’s been nearly no research or application of technology to aid in memorization techniques to legal education.²⁰² For example, a search of the Westlaw database reveals only two passing references to spaced repetition.²⁰³ Even with the growth of “law & rhetoric” as a discipline, few of the texts devoted to the topic make mention of memorization as a canon of rhetoric (it was one of the five all ancient Romans learned), let alone application of the ancient skill of *memoria* using the modern science of spaced repetition learning.²⁰⁴ To help

²⁰⁰ See *What to Expect in Your First Year of Law School*, PRINCETON REVIEW (last visited Jan. 29, 2017), archived at <https://perma.cc/XG9N-7D93> (detailing the typical first-year curriculum of law school education).

²⁰¹ See Delece Smith-Barrow, *Use First Year of Law School to Prepare for the Bar*, U.S. NEWS (May 23, 2013), archived at <https://perma.cc/36B3-NRWU> (describing how to effectively use your 1L year as preparation for the bar exam).

²⁰² See Adam Nguyen, *What is the Future of Law as it Converges with Technology?*, LAW TECHNOLOGY TODAY (Apr. 10, 2015), archived at <https://perma.cc/92YL-NL3N> (discussing the need to incorporate technology in the legal classroom).

²⁰³ See, e.g., Jean M. Holcomb, *Maintaining Your Competitive Edge*, 101 LAW LIBR. J. 121, 123-24 (2009) (advocating for the use of spaced repetition in order to become a master of your field); Helen H. Kang, *Use of Role Play and Interview Modes in Law Clinic Case Rounds to Teach Essential Legal Skills and to Maximize Meaningful Participation*, 19 CLINICAL L. REV. 207, 225 n. 58 (2012) (illustrating the use of spaced repetition to prevent students from forgetting important skills).

²⁰⁴ See KRISTEN K. ROBBINS-TISCIONE, *RHETORIC FOR LEGAL WRITERS: THE THEORY AND PRACTICE OF ANALYSIS AND PERSUASION* 102 (1st ed. 2009) (listing canon terms and their modern definitions). This is the only recent book devoted to the intersection of rhetoric and modern law. *Id.* It acknowledges that the canon of memorization survives in modern-day speech and communications classes, but does not address it because *memoria* is more closely related to speaking than the book’s primary focus, writing. *Id.* See also EDWARD P.J. CORBETT & ROBERT J. CONNORS, *CLASSICAL RHETORIC FOR THE MODERN STUDENT* 22 (4th ed. 1999) (commenting on the Greek concept of *memoria* being left out of rhetoric texts until the eighteenth century). Professors Corbett and Connors do not devote discussion to *memoria* in their excellent treatise because they state that memorization was the area that “received the least attention in the rhetoric books.” *Id.* They (incorrectly) posit that this neglect resulted from the fact that “not much can be said, in a theoretical way, about the process of memorizing . . .” *Id.* See also Carroll C. Arnold, *Oral Rhetoric, Rhetoric and Literature*, 40 PHILOSOPHY & RHETORIC 191, 198 n.

close that gap, this section sketches out a few ways SR could be used by learners at various stages of legal learning, from law school, to the bar, through practice.²⁰⁵

A. *For Bar Preppers*

A prerequisite to success on the bar exam is memorization.²⁰⁶ The shortcomings of how it is tested is specifically the gap that SR does best in filling.²⁰⁷ As one scholar said, the bar exam “simply tests whether the applicant has memorized the...rules and can apply them to a multiple-choice question.”²⁰⁸ Without wading into the wisdom of how regulators choose to test law school graduates, the fact remains that they *are* required to memorize vast amounts of information.²⁰⁹ Simply put, there is no better tool for teaching people to memorize rules than SR.²¹⁰

The bar exam is also a perfect place for applying SR because the topics covered are clearly defined, particularly with the multi-state bar exam (“MBE”).²¹¹ The MBE covers seven topics, and the exam’s creators, the National Conference of Bar Examiners

17 (2007) (describing how *memoria* disappeared from the “language and considerations” of rhetoric). Other scholars suggest that *memoria* has been forgotten not because there is not much to be said about it in a theoretical way, but because the study of rhetoric has shifted away from oral rhetoric to focus on written rhetoric.

Id.

²⁰⁵ See *infra* Part V (elaborating further on the ways law students and the legal profession could benefit from spaced repetition).

²⁰⁶ See Kimber Russell, *Bar Points: How to Effectively Memorize Bar Exam Material*, KAPLAN TEST PREP (June 26, 2012), archived at <https://perma.cc/FPB8-Q3TR> (detailing memorization success tips for passing the bar exam).

²⁰⁷ See *id.* (stating different methods to use spaced repetition for memorization).

²⁰⁸ See Andrea A. Curcio, *A Better Bar: Why and How the Existing Bar Exam Should Change*, 81 NEB. L. REV. 363, 380 (2002) (describing the downfalls of the MPRE, a pre-requisite ethics exam for the Massachusetts Bar Exam, and how it does not test relevant skills of lawyering).

²⁰⁹ See *id.* at 364 (arguing that lawyers need more skills than what is tested on the Bar).

²¹⁰ See SERIOUS SOFTWARE FOR SERIOUS LAW STUDENTS, *supra* note 30 (explaining the benefits of spaced repetition as being the best way to memorize legal theories and principles).

²¹¹ See 2017 MBE Subject Matter Outline, NAT’L CONF. BAR EXAM’RS 1 (last visited Jan. 30, 2017), archived at <https://perma.cc/VW3W-L86S> (outlining the subject matter for the 2017 Multi-State Bar Exam and providing a link to the Subject Matter Outline).

(“NCBEX”), publishes an MBE subject matter outline with the precise coverage within those topics.²¹² Even more helpfully, the NCBEX over-tests some subtopics, and under-tests others, and the outline lays out the relative frequency of questions.²¹³ For example, Torts has four categories of questions (Intentional Torts, Negligence, Strict Liability, and Other Torts).²¹⁴ Yet, the NCBEX outline discloses that even though Negligence is only one of four Torts categories, it makes up approximately half the questions.²¹⁵ What this means for the astute bar prepper is that by focusing on those over-tested areas, they can play “moneyball”²¹⁶ by covering 50% of the points in Torts by studying only 25% of the material.²¹⁷

Applying this to creating a SR tool for bar preppers, the goal would be to use experts to create content that corresponds to the most-tested MBE topics.²¹⁸ Of course, there is also value in helping students memorize less-tested topic areas, but maximum value is gained for them with minimum effort by starting with most-tested concepts.²¹⁹ Students can also use SR to collaborate to create state-specific flashcards that correspond to essay topics in their own jurisdiction.²²⁰

²¹² See *id.* at 1-8 (listing the sub-topics tested within each subject area).

²¹³ See *id.* (highlighting the frequency of subtopics tested).

²¹⁴ See *id.* at 8 (providing specific examples which are tested and how frequently).

Each of these four topics has several sub-topics delineated as well. *Id.*

²¹⁵ See *id.* (stating that half of the questions in Tort section will be based on negligence).

²¹⁶ See MICHAEL LEWIS, MONEYBALL xiv (W.W. Norton & Company, 2004) (illustrating a term using an analogy to baseball which focused on using data-driven analytics to find value in situations where the conventional wisdom did not always find it).

²¹⁷ See 2017 MBE Subject Matter Outline, *supra* note 211, at 8 (calculating the most efficient way to study Tort material).

²¹⁸ See SERIOUS SOFTWARE FOR SERIOUS LAW STUDENTS, *supra* note 30 (highlighting use of spaced repetition for Bar Exam preparation).

²¹⁹ See Brian Hahn, 5 Things I Did Differently the Second Time to Pass the Bar Exam, BAR EXAM TOOLBOX (Nov. 4, 2014), archived at <https://perma.cc/3Q5Y-ZJNS> (noting that practicing issues that are statistically more likely to appear on the exam will lead to learning most frequently tested issues first).

²²⁰ See How to Make Bar Exam Flashcards, BAR ADVISOR (last visited Jan. 30, 2017), archived at <https://perma.cc/9K6P-YGEE> (describing different methods of reviewing flashcards).

B. For Law Students in School

The time now spent in law school classes drilling students on rote memorization could be outsourced to a better teacher of it: SR.²²¹ The use of SR could open up law school classes to higher-level discussion and learning because, by using it, students would arrive to class knowing all of the relevant black letter law.²²² That would allow the professor to spend her time helping the students to think about analyzing and applying that information.²²³

For every course, students would simply create a deck of flashcards and load them onto their SR.²²⁴ Over the course of the semester, the students could both study, and add, to the decks.²²⁵ When exam time came, there would be no cramming to do.²²⁶ Instead, students would have time free to practice the skill of exam-taking.²²⁷

This method could also build community among students.²²⁸ If they were all able to collaborate on content creation for their class-

²²¹ See Josette Akresh-Gonzales, *Spaced Repetition: The Most Effective Way to Learn*, NEJM KNOWLEDGE (Nov. 19, 2015), archived at <https://perma.cc/G9SC-B57L> (illustrating the benefits of using SR over mechanical and habitual memorization for law students).

²²² See Doretta McGinnis, *Can Spaced Repetition Help you Learn the Law?*, BAR EXAM TOOLBOX (Oct. 5, 2016), archived at <https://perma.cc/UKQ4-HMGD> (providing an example of how the SR method can benefit class discussion in law school).

²²³ See Shellenbarger, *supra* note 8 (highlighting how SR programs allow teachers to alter traditional teaching methods).

²²⁴ See Chris Forno, *How Does Spaced Repetition Work?*, VOCABULINK (last visited Jan. 30, 2017), archived at <https://perma.cc/CMF2-BNHC> (illustrating how spaced repetition improves on traditional flashcard memorization methods).

²²⁵ See Tanagrabeast, *A Year of Spaced Repetition Software in the Classroom*, LESSWRONG (July 4, 2015), archived at <https://perma.cc/A7T6-48RT> (describing the process of adding flashcards to the deck over the course of a semester).

²²⁶ See Akresh-Gonzales, *supra* note 221 (explaining the benefits of using spaced repetition to study for exams).

²²⁷ See Akresh-Gonzales, *supra* note 221 (acknowledging the benefits of spaced repetition for exam preparation).

²²⁸ See *Welcome to SeRious*, *supra* note 147 (describing how using spaced repetition can foster collaboration among students).

wide flashcard deck, they would work together in ways that law students do not now.²²⁹ If the class's professor was willing to review the content with students (and why wouldn't she, this is an easy tool for helping make her own job easier and more interesting)²³⁰, student buy-in would be high.²³¹

Also, because the first-year courses are the core of the multi-state portion of the bar exam, by using spaced repetition during the first year of law school, the students could simply continue reviewing their 1L content during law school.²³² Because the times between study sessions expands exponentially, it would be reasonable to expect a student to only have to look at first year flashcards a few times over the student's final two years of school, and the student would then have "banked" a good deal of knowledge when the bar exam came, allowing for devoting time to other tasks (like state-specific essay topics, or practicing essay writing to wring the maximum points out of the local portions of the exam).²³³

C. For Practitioners

Using SR should not end once a law student graduates and passes the bar.²³⁴ The ability to remember key information is important to many forms of law practice.²³⁵ For example, a new litigator will be expected to cite specific cases and specific propositions of law, day-in-and-day-out, even as a rookie.²³⁶ Imagine: a new DA thrown into arguing bail matters will need to remember the relevant

²²⁹ See *Welcome to SeRiouS*, *supra* note 147 (highlighting new and innovative ways law students can collaborate using spaced repetition).

²³⁰ See *Welcome to SeRiouS*, *supra* note 147 (outlining how unprecedented professor engagement is beneficial to flashcard learning).

²³¹ See *Welcome to SeRiouS*, *supra* note 147 (emphasizing the importance for students to use quality flashcards).

²³² See Smith-Barrow, *supra* note 201 (articulating how use of spaced repetition during 1L year is natural Bar preparation).

²³³ See Gabriel Teninbaum, *Spaced Repetition: A tool to help you learn way more in way less time*, ABA FOR LAW STUDENTS (Mar. 17, 2016), archived at <https://perma.cc/JA7S-5XY3> (addressing the importance to prepare for the Bar exam with Spaced Repetition during 1L year).

²³⁴ See *id.* (discussing how Spaced Repetition should be used at all stages of a lawyer's career).

²³⁵ See *id.* (focusing on the importance of remembering information after using Spaced Repetition methods).

²³⁶ See Gymer, *supra* note 193 (considering the skills needed as a new lawyer).

standards for determining bail, and should be prepared to cite the cases underlying it.²³⁷ A new associate in a med-mal firm would need to remember vast stores of medical terminology (not to mention a distinct body of case law).²³⁸ An attorney prepping for an argument before an appellate court needs to be able to cite a huge array of relevant cases, along with the propositions of law they stand for.²³⁹ This is precisely where SR shines: it is best at helping people remember quantities of information that they want to learn well, and learn for the long-term.²⁴⁰

Beyond specifically legal facts, attorneys are businesspeople for whom SR can help.²⁴¹ For example, using SR to remember the interests and family members' names of referring attorneys would seem a smart business move, and one of many ways SR could be used by lawyers-as-businesspeople.²⁴²

D. *Limitations and Caveats*

While SR provides a unique opportunity for lawyers and law students to improve their effectiveness, the technique is not a cure-all.²⁴³ First, using SR requires more than just looking at flashcards.²⁴⁴ Users still must *learn* the material and context is necessary to be able to make use of it.²⁴⁵ Put differently, being able to identify the defini-

²³⁷ See Niedwiecki, *supra* note 195, at 41 (recognizing the need for lawyers to constantly learn new topics and apply them to their cases).

²³⁸ See Niedwiecki, *supra* note 195, at 41 (articulating why attorneys need strong research skills to support unique areas of litigation).

²³⁹ See Gymer, *supra* note 193 (explaining the importance of memory skills when developing arguments).

²⁴⁰ See SERIOUS SOFTWARE FOR SERIOUS LAW STUDENTS, *supra* note 30 (demonstrating the usefulness of a spaced repetition program).

²⁴¹ See *Welcome to SeRiouS*, *supra* note 147 (noting the diverse benefits to individuals using SeRiouS).

²⁴² See *Welcome to SeRiouS*, *supra* note 147 (inferring that a lawyer may use SeRiouS in their personal life).

²⁴³ See *Welcome to SeRiouS*, *supra* note 147 (recognizing that students cannot rely on SeRiouS alone for bar preparation as they still must know the material inside and out).

²⁴⁴ See *Welcome to SeRiouS*, *supra* note 147 (mentioning the process of learning through spaced repetition).

²⁴⁵ See *Welcome to SeRiouS*, *supra* note 147 (noting that the software cannot do the learning for you and self-motivated learning is necessary for successful use of SeRiouS).

tion of a term or to list the elements of a cause of action is not synonymous with being able to apply the definition to a real client's case.²⁴⁶ The work of lawyering begins with thorough knowledge of black letter law, but is meaningless without training in analyzing, organizing, and expressing it.²⁴⁷ SR is useful in supporting these goals in the sense that it allows for flipped classrooms, where professors needn't drill students on elements (because they've learned them on their own using SR!), but can instead spend classroom time digging into application of the law.²⁴⁸ Nonetheless, stand-alone use of spaced repetition in a common law legal system²⁴⁹ is like having medical students the details of anatomy and steps in a surgical procedure; yet not letting them practice holding the scalpel or making an incision.²⁵⁰ Ultimately, SR can be the core building block to success in the actual practice of law, but can never fully replicate the human experience and mentoring needed to excel.²⁵¹

Second, cramming is not a good technique for long-term learning and memorization.²⁵² Crammers trade short-term benefits for very, very weak long-term results.²⁵³ Nonetheless, cramming *does* work in the short term.²⁵⁴ Adding to the challenge of recognizing that SR is a superior technique, users often believe cramming is

²⁴⁶ See Gymer, *supra* note 193 (stressing the need to not only remember large quantities of information, but to also be able to apply it to real world scenarios).

²⁴⁷ See Gymer, *supra* note 193 (reaffirming the skills required to be an effective lawyer).

²⁴⁸ See *Welcome to SeRious*, *supra* note 147 (advocating change in law student learning where they study with spaced repetition on their own and deepen their understanding in the classroom).

²⁴⁹ See *SERIOUS SOFTWARE FOR SERIOUS LAW STUDENTS*, *supra* note 30 (encouraging the use of SeRious for American law students). Common law is referenced here because it is feasible that deep memorization could play a larger role in civil law systems, where analysis of precedent is of secondary importance to the ability to reference code and commentary that are less in need of analysis. *Id.*

²⁵⁰ See Kerfoot et al., *supra* note 3 (outlining a study involving the usefulness of spaced repetition to medical school training).

²⁵¹ See *Welcome to SeRious*, *supra* note 147 (reiterating that the student cannot rely on the computer program alone).

²⁵² See Akresh-Gonzales, *supra* note 221 (contesting the notion that cramming has long term benefits).

²⁵³ See Akresh-Gonzales, *supra* note 221 (citing the limited effectiveness of cramming for your short term retention).

²⁵⁴ See Akresh-Gonzales, *supra* note 221 (acknowledging that cramming can be a successful study technique).

more effective.²⁵⁵ Built into the cramming vs. spacing decision is that fact that, while spacing is nearly universally more effective than cramming.²⁵⁶ This means that educating users on the strength of SR, and its counter-intuitive benefits, will be useful to encouraging users to get maximum benefit from it.²⁵⁷

VI. Conclusion

More than two thousand years ago, a rhetorician arguing in a Roman court had to be prepared to respond to interruptions, change an argument's direction, omit prepared sections and to improvise.²⁵⁸ The advocate also needed to have memorized the complex body of Roman law.²⁵⁹ To prepare for this ordeal, the advocate relied on a series of memorization techniques developed and refined by famed orators like Aristotle, Quintilian and Cicero.²⁶⁰ To ancient Romans, *memoria* (or *mneme*, to the Greeks) was one of the five canons of rhetoric that every educated citizen had to master.²⁶¹

For today's legal professionals, memorization is no less important. Modern trial lawyers face the same challenge as Roman lawyers in terms of preparing for arguments while requiring flexibility to re-order or re-frame to respond to judges' inquiries. Memorization is also vital to students of the law, who face two memory-stretching challenges the Romans never did: issue-spotting exams and the bar.

Yet, modern law students and lawyers take on the challenges of recalling what they have learned without any systematic training in memorization. As a result, more students struggle in law school than

²⁵⁵ See Akresh-Gonzales, *supra* note 221 (discussing the widespread belief that cramming is the preferable method of studying).

²⁵⁶ See Branwen, *supra* note 58 (summarizing participants' perception of which method is more effective, with results showing that after the first study session, 72% of participants in a recent study believed that *cramming* had been more effective than spacing).

²⁵⁷ See Akresh-Gonzales, *supra* note 221 (encouraging students to incorporate spaced repetition study habits into their routines).

²⁵⁸ See ENCYCLOPEDIA OF RHETORIC 113 (Thomas Sloane ed., 2001) (describing memorization as an element of the canons of rhetoric).

²⁵⁹ See *id.* (articulating the quantity of information that Greek and Latin students were required to memorize).

²⁶⁰ See ROBBINS-TISCIONE, *supra* note 204, at 101-02 (articulating the memorization techniques used by Greek and Roman scholars).

²⁶¹ See ROBBINS-TISCIONE, *supra* note 204, at 101-02 (providing examples of Greek and Latin terms that were used to describe different attributes of rhetoric).

need-be, more students fail the bar than should, and more practitioners are ineffective in representing clients than necessary.

There is no Wikipedia available while taking the bar exam and no Google searching allowed during the middle of an oral argument. Law students and legal professionals simply must *know* certain things – they must memorize them. By leveraging SR, we can help them learn more effectively and efficiently.