Teaching the Digital Caveman: Rethinking the Use of Classroom Technology in Law School

*James B. Levy**

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* Associate Professor, Nova Southeastern University, Shepard Broad College of Law. J.D., Suffolk University School of Law (1986); A.B., Colby College (1982). Follow the digital caveman on Twitter at @DigiCaveman. This Article is dedicated to Doreen and Oscar.

INTRODUCTION

Law students who have never lived in a world without computers or the Internet are known as "digital natives."[1] Many assume that constant exposure to these technologies has changed the way our students think and learn. As a result, legal educators have also changed the way they teach to accommodate this supposedly new learning style by relying more heavily on visual tools like laptops and PowerPoint.[2] The assumptions about digital natives are considered so self-evident based on what we see around us that no one bothers to question them. In reality, these assumptions are not accurate but reflect instead the "illusion of truth" in which observations and beliefs are substituted for fact.[3] The purpose of this Article is to encourage legal educators to be more skeptical about these claims, particularly when it comes to the use of classroom technology.[4]

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1 *See* Marc Prensky, *Digital Natives, Digital Immigrants, Part 1,* 9 ON THE HORIZON 1 (2001). Other terms used to describe students born into a digital world include Generation Y, i-Generation, Net-Generation, Homo Zapiens, and Millennials. Kwok-Wing Lai & Kian-Sam Hong, *Technology Use and Learning Characteristics of Students in Higher Education: Do Generational Differences Exist?*, 46 BRIT. J. EDUC. TECH. 725, 726 (2015).

2 PowerPoint is so 2013; for purposes of this Article, I use it synonymously with visual presentation tools generally, like Prezi.

3 *See* Sue Bennett et al., *The 'Digital Natives' Debate: A Critical Review of the Evidence*, 39 BRIT. J. EDUC. TECH. 775, 779 (2008) (though many claims about digital natives appeal to common sense they lack empirical support); Sue Bennett & Karl Maton, *Beyond the 'Digital Natives' Debate: Toward a More Nuanced Understanding of Students' Technology Experiences*, 26 J. COMPUTER ASSISTED LEARNING 321, 328 (2010); *see also* Daniel Haun, *Repetition, Availability and Truth*, *in* IS THE INTERNET CHANGING THE WAY YOU THINK?: THE NET'S IMPACT ON OUR MINDS AND FUTURE 293, 293 (John Brockman ed., 2011) [hereinafter IS THE INTERNET CHANGING THE WAY YOU THINK?] (psychologists report that people have the tendency to mistake repetition for truth owing to the "illusion of truth" effect); *infra* p. 252 and accompanying notes.

4 In fact, there is little to no evidence "digital natives" think or learn differently than other students. *See* Bennett et al., *supra* note 3, at 780, 783; Bennett & Maton, *supra* note 3, at 328; Mark Bullen et al., *Digital Learners in Higher Education: Generation Is Not the Issue*, 37 CANADIAN J. LEARNING & TECH., Spring 2011, at 1, 17–18 (no evidence that so-called digital native university students have different learning needs than others); Ellen J. Helsper & Rebecca Eynon, *Digital Natives: Where Is the Evidence?*, 36 BRIT. EDUC. RES. J. 503, 517–18 (2010) (observing no empirical support for making distinction between "digital natives" and "digital immigrants"; continuing to do so could be harmful to their education); Chris Jones & Binhui Shao, *The Net Generation and Digital Natives: Implications for Higher Education*, HIGHER EDUC. ACAD., YORK 1, 2, 34 (2011), http://oro.open.ac.uk/30014/1/Jones_and_Shao-Final.pdf [http://www.perma.cc/ML7N-BHSG] (showing that meta-analysis of global studies, including those from U.S., find no support for generational differences in university students' attitudes, use, and desire for classroom technology); Chris Jones et al., *Net Generation or Digital Natives: Is There a Distinct New Generation Entering University?*, 54 COMPUTERS & EDUC. 722, 731 (2010); Lai & Hong, *supra* note 1, at 726; Anne Mangen & Don Kuiken, *Lost in an iPad: Narrative Engagement on Paper and Tablet*, 4 SCI. STUDY LITERATURE 150, 171 (2014) (concluding so-called "digital natives" have the same preference and cognitive response to print as "digital immigrants," suggesting lack of support for "generational differences"

New forms of media have always led to a "moral panic" that technology is changing the way people think.[5] Educators see the influence of new technologies on popular culture and worry that if they do not quickly embrace them as well, they will seem out of date, and their students will get left behind.[6] Initially, however, no research exists on the classroom effectiveness of these technologies, so educators rely instead on intuition to guide their choices.[7] But the track record for making decisions in this way is fraught with mistaken assumptions and failed experiments.[8]

Seeing all this through the more objective lens of "learning science," however, shows that the way we think and learn has not changed much in 50,000 years.[9] Thus, a more accurate

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claimed by Prensky and others); *see also* DURHAM STUDY, *infra* note 228, at 20. Another mistaken assumption about today's students is that they are all tech savvy. *See infra* p. 252 and note 54.

5 Steven Pinker, Opinion, *Mind Over Mass Media*, N.Y. TIMES, at A31 (June 10, 2010), http://www.nytimes.com/2010/06/11/opinion/11Pinker.html [http://perma.cc/736M-ZNEB] [hereinafter Pinker, *Mind Over Mass Media*]; *see* WILLIAM POWERS, HAMLET'S BLACKBERRY 194–97 (2010) (early 1960s characterized by widespread fear that mass media was turning the public into "helpless automatons"); MARYANNE WOLF, PROUST AND THE SQUID: THE STORY AND SCIENCE OF THE READING BRAIN 70–71 (2007) (Socrates worried transition from oral to written culture threatened society); Vaughan Bell, *Don't Touch That Dial!: A History of Media Technology Scares, From the Printing Press to Facebook*, SLATE (Feb. 15, 2010, 7:00 AM), http://www.slate.com/articles/health_and_science/science/2010/02/dont_touch_that_dial.html [http://perma.cc/JKA8-34S4] (in the 1930s, educators worried radio was having a deleterious effect on learning by dividing students' attention between the "humdrum preparation of school assignments and the compelling excitement of the loudspeaker"); *see also* Nicholas A. Christakis, *There Is No New Self*, *in* IS THE INTERNET CHANGING THE WAY YOU THINK?, *supra* note 3, at 202, 203 (the Internet is no different than equally monumental brain-enhancing technologies like books and telephones, yet it is doubtful they changed the way we think either); Mihaly Csikszentmihalyi, *I Must Confess to Being Perplexed*, *in* IS THE INTERNET CHANGING THE WAY YOU THINK?, *supra* note 3, at 374, 374 (preeminent professor of psychology says no evidence the printing press changed the way we think much less the Internet); Carissa Young, "*With Great Power Comes Great Responsibility": American Comic Book Censorship and the Cold War Consensus*, 1 NORTHWEST PASSAGES 164, 166 (2014) (the 1950s saw widespread fear comic books harmed student learning).

6 *See infra* p. 251 and accompanying notes.

7 *See* BENEDICT CAREY, HOW WE LEARN 213 (2014) (most of our instincts about learning are misplaced, incomplete, and flat wrong); STANISLAS DEHAENE, READING IN THE BRAIN: THE SCIENCE AND EVOLUTION OF A HUMAN INVENTION 327 (2009) (educational decisions are often grounded in well-meaning intentions that turn out to be wrong resulting in misguided teaching practices); John Palfrey, *Smarter Law School Casebooks*, *in* LEGAL EDUCATION IN THE DIGITAL AGE 106, 122–23 (Edward Rubin ed., 2012) (law professors need to incorporate research from other fields to inform their teaching instead of relying on observable student behavior); *infra* p. 252 and accompanying notes.

8 *See infra* Part I.

9 Roger Schank, *The Thinking Process Hasn't Changed in 50,000 Years*, EDGE, https://edge.org/response-detail/11519 [https://perma.cc/SJV9-HEVH] [hereinafter Schank, *The Thinking Process*] (Professor Schank, one of world's leading scholars on artificial intelligence, learning theory, cognitive science, and virtual learning environments, says "the Internet has not changed the way [we] think," only the way we gather information has changed); *see* HANK DAVIS, CAVEMAN LOGIC: THE PERSISTENCE OF PRIMITIVE

picture of how today's law students really learn is suggested by the title in that they use digital tools to gather information, but still process it into knowledge using the original factory equipment of our caveman ancestors.[10]

THINKING IN A MODERN WORLD 33–34 (2009); Roger Schank, *Everyone is an Expert*, *in* IS THE INTERNET CHANGING THE WAY YOU THINK?, *supra* note 3, at 355, 355 [hereinafter Schank, *Everyone is an Expert*] (the Internet is not changing the way anyone thinks; that has not changed since caveman days); Pinker, *Mind Over Mass Media, supra* note 5 (environmental factors like technology do not revamp the basic information processing capacities of the brain); Matt Richtel, *Technology Changing How Students Learn, Teachers Say*, N.Y. TIMES, at A18 (Nov. 1, 2012), http://www.nytimes.com/2012/11/01/education/technology-is-changing-how-students-learn-teachers-say.html?emc=eta1&_r=0 [http://perma.cc/HJ9M-T7NU] [hereinafter Richtel, *Technology Changing How Students Learn, Teachers Say*] (technology may be changing student learning behaviors but no long-term studies support the claim that it is changing attention spans); Daniel T. Willingham, Opinion, *Smartphones Don't Make Us Dumb*, N.Y. TIMES, at A23 (Jan. 21, 2015), http://www.nytimes.com/2015/01/21/opinion/smartphones-dont-make-us-dumb.html [http://perma.cc/X6VP-TS56] [hereinafter Willingham, *Smartphones Don't Make Us Dumb*]; *infra* pp. 267–69 and accompanying notes. *But see* Johan J. Bolhuis et al., *Darwin in Mind: New Opportunities for Evolutionary Psychology*, 9 PLOS BIOLOGY 1, 2 (July 2011), http://www.plosbiology.org/article/fetchObject.action?uri=info:doi/10.1371/journal.pbio.1001109&representation=PDF [http://perma.cc/4XKC-HBPN] (noting new research challenging the assumption that evolution stopped 50,000 years ago and that man-made environmental changes including advances in agriculture, domestication of animals, etc. have resulted in genetic, evolutionary changes within the last 10,000 years; it is possible some could occur in as few as twenty-five generations).

As a preliminary matter, it is important to define what is meant by "thinking." From a phenomenological perspective, nearly all environmental influences can "change" our perceptions and the content of our thoughts. In the educational context, everything from the color of the chalkboard to the pictures hanging on the wall may arguably affect the way students think and learn to a small degree. *Compare* Bradley Emerling, *Lessons Learned from a Chalkboard: Slow and Steady Technology Integration*, LARRY CUBAN ON SCH. REFORM & CLASSROOM PRAC. (Apr. 26, 2015, 1:00 AM), https://larrycuban.wordpress.com/2015/04/26/lessons-learned-from-a-chalkboard-slow-and-steady-technology-integration-bradley-emerling/ [https://perma.cc/S7WD-GHAB] (research shows green colored chalkboards help students concentrate better than whiteboards), *with* Sapna Cheryan et al., *Designing Classrooms to Maximize Student Achievement*, 1 POL'Y INSIGHTS BEHAV. & BRAIN SCI. 4, 8 (2014) (study found that placing a photo of Bill Clinton in a classroom caused males to speak longer than females; replacing it with a photo of Hillary Clinton eliminated gender differences in speech length).

However, this Article is responding to the claim that digital technologies have changed the way our students process information such that we need to also change the way we teach. Yet so far there is no evidence to support that assertion. *See* Mark Pagel, *Brain Candy & Bad Mathematics*, *in* IS THE INTERNET CHANGING THE WAY YOU THINK?, *supra* note 3, at 70, 70 (professor of evolutionary biology says we know the Internet has not changed the brain because we can visit people who do not have Internet access and they think the same as we do); Steven Pinker, *Not at All*, *in* IS THE INTERNET CHANGING THE WAY YOU THINK?, *supra* note 3, at 86, 87 (it is "ludicrous" to believe that digital technology has changed the way scientists think compared to a decade ago); *supra* note 4; *see also* DAVIS, *supra*, at 186 ("extraordinary claims require extraordinary evidence"); Gregory Paul, *Hell if I Know*, *in* IS THE INTERNET CHANGING THE WAY YOU THINK?, *supra* note 3, at 122, 122 (the only way to know if the Internet is changing the way we think and learn is to run a controlled experiment, and it is unclear how we would even do that). Significantly, experts tell us it is unlikely the brain is even capable of the changes suggested by those who claim the existence of a so-called cognitive divide. *See infra* pp. 267–69.

10 STEVEN PINKER, HOW THE MIND WORKS 343 (1997) [hereinafter PINKER, HOW THE

This Article is based on the premise that the most important skill we teach in law school, particularly in the first year, is how to "think like a lawyer."[11] The critical thinking and problem solving skills at the heart of "thinking like a lawyer" are arguably more important today than ever, given a job market where lawyers may increasingly find that only the most intellectually prepared get hired to handle the difficult tasks that cannot otherwise be commoditized and outsourced to cheaper, non-lawyer alternatives.[12] In light of the substantial evidence that digital technologies can undermine the very skills we are trying to impart, we need to reassess the commonly held assumptions about how best to teach so-called "digital native" law students.[13]

This Article begins in Part I with a short history of modern classroom technology, why it has routinely failed to produce the student learning outcomes promised, and the lessons this can teach us. To make better informed decisions about whether and how best to use classroom technologies in ways that advance our learning objectives, Part II discusses the "science" of how our students really learn.[14] In light of these discussions, Part III

MIND WORKS]; *see* DAVIS, *supra* note 9, at 33–40.

11 *See* WILLIAM M. SULLIVAN ET AL., EDUCATING LAWYERS: PREPARATION FOR THE PROFESSION OF LAW 13, 33, 87, 195 (2007) (Carnegie report on legal education finds that the "cognitive apprenticeship" in how to "think like a lawyer" is the primary goal of the first-year curriculum); Jay Sterling Silver, *Pedagogically Sound Cuts, Tighter (Not Looser) Accreditation Standards, and a Well-Oiled Doomsday Machine: The Responsible Way Out of the Crisis in Legal Education*, 66 RUTGERS L. REV. 353, 391 (2014) (cultivation of critical thinking skills is not just central to legal education, it *is* legal education).

12 *See* RICHARD SUSSKIND, THE END OF LAWYERS? RETHINKING THE NATURE OF LEGAL SERVICES *passim* (2010); John O. McGinnis, *Law Schools Must Respond to Technological Change*, LIBR. L. & LIBERTY (Feb. 17, 2015), http://www.libertylawsite.org/2015/02/17/law-schools-must-respond-to-technological-change/ [http://perma.cc/8BVE-6GZX] (during era when lawyers are being replaced by technology and other low cost options, schools need to focus on producing students who are better, more creative thinkers because only those skills will remain beyond the reach of the machines).

Of course, teaching students "practical legal skills" is also a high priority these days even though, to date, there is not much evidence it actually leads to jobs. *See* Deborah J. Merritt, *An Employment Puzzle*, LAW SCHOOL CAFÉ (June 18, 2013, 10:24 PM), http://www.lawschoolcafe.org/thread/an-employment-puzzle/ [http://perma.cc/XYE7-6HJT] (law school that changed curriculum to focus on practical skills got accolades from legal educators but employment outcomes for graduates actually declined); Jason W. Yackee, *Does Experiential Learning Improve JD Employment Outcomes?* (Univ. of Wis. Legal Stud. Res. Paper No. 1343), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=255 8209 (no statistical relationship between opportunities for legal skills training in law school and employment outcomes). *But see infra* note 227.

13 It is not just the misuse of laptops during class that is the problem. Digital technologies can also hinder the development of analytical skills, critical reading skills, and other vital cognitive skills like attention, focus, and the capacity for deep, reflective thinking. *See infra* Part III.

14 "Learning science" refers to interdisciplinary work from fields that include cognitive science, neurobiology, and evolutionary psychology to explain the mental

suggests strategies for using, and knowing when not to use, popular classroom technologies like laptops and PowerPoint in ways that promote the critical thinking skills we want our students to develop. Part IV concludes by recommending that we reject popular stereotypes and clichés about how best to teach digital native law students, and instead employ a hybrid approach to classroom technology that blends traditional tools with new, digital ones in ways that better match our methods with the learning outcomes we seek.

I. "IT'S DÉJÀ VU ALL OVER AGAIN": A BRIEF HISTORY OF MODERN CLASSROOM TECHNOLOGY[15]

Teaching has always depended on effectively communicating information and ideas to students. As electronic technologies began to proliferate in the early twentieth century, educators naturally looked for ways to adapt them to the classroom. This led to a series of educational experiments over the past one hundred years involving the paradigm shifting technologies of their day, including film, radio, television, and early desktop computers.[16] Each promised to "revolutionize" the way students learn.[17] In some cases, these experiments were preceded by an "academic moral panic," much like the one today in that educators believed students raised on new forms of media had developed unique learning styles, which meant teaching methods also had to change to accommodate this new way of thinking.[18]

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processes involved in learning, the neurobiological changes that occur, and the evolutionary circumstances that explain why human cognition is constrained in the ways that it is. Reflecting this synergy, a new field has emerged in recent years called "Evolutionary Cognitive Neuroscience" that incorporates all these disciplines. Austen Krill et al., *Where Evolutionary Psychology Meets Cognitive Neuroscience: A Précis To Evolutionary Cognitive Neuroscience*, 5 EVOLUTIONARY PSYCHOL. 232, 233 (2007); *see* PINKER, HOW THE MIND WORKS, *supra* note 10, at 342, 352 (to fully succeed as teachers, it is critical to understand not only how the brain works, but also what it was originally designed to do); ROGER SCHANK, TEACHING MINDS: HOW COGNITIVE SCIENCE CAN SAVE OUR SCHOOLS, at xv, xvi, 13, 16 (2011) [hereinafter SCHANK, TEACHING MINDS] (educators need to understand how the brain works); Palfrey, *supra* note 7, at 122–23 (law professors need to incorporate research from other fields to better inform their teaching).

15 *Yogi Berra*, WIKIQUOTES, http://en.wikiquote.org/wiki/Yogi_Berra [http://perma.cc/46UN-29AR].

16 LARRY CUBAN, TEACHERS AND MACHINES: THE CLASSROOM USE OF TECHNOLOGY SINCE 1920, at 3, 19, 27, 72–73 (1986) [hereinafter CUBAN, TEACHERS AND MACHINES]; AUDREY WATTERS, THE MONSTERS OF EDUCATION TECHNOLOGY 21–22 (2014) (noting that early classroom computer technology used in the 1960s included many features of today's counterparts such as message boards, chat rooms, instant messaging, multiplayer games, and shared screens).

17 LARRY CUBAN, OVERSOLD AND UNDERUSED: COMPUTERS IN THE CLASSROOM 130 (2001) [hereinafter CUBAN, OVERSOLD AND UNDERUSED].

18 Bennett et al., *supra* note 3, at 782 ("moral panic" refers to a form of public discourse, often initiated by the media using sensationalist, dramatic language, in which

Ironically, many of the promises made about these early classroom technologies are remarkably similar to the ones made today about digital classroom tools. For instance, Thomas Edison began predicting in 1913 that "film will soon replace the textbook because there is nothing that is taught by a book that cannot be taught better through the eye."[19] Educators have been making the identical claim about "visual," screen-based digital technologies for more than a decade.[20] By the 1920s, "education by radio" was being hailed as an innovative use of new media that would "bring the world to the classroom, to make universally available the services of the finest teachers, the inspiration of the greatest leaders," which is the very same promise made today about MOOCs.[21] A few decades later, educators were wiring classrooms for television in the belief it was a "mode of learning that is valuable because kids are oriented to the electronic age," reflecting the same assumptions about "digital natives" who have supposedly developed a unique learning style because of their constant exposure to technology.[22]

None of these experiments worked as promised, and neither were fears realized that new technologies had changed the way students think or learn.[23] No doubt Edison's prediction seemed

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a particular group in society, like digital natives, is portrayed as radically different and posing a threat to the status quo); *see* Bennett & Maton, *supra* note 3, at 328 (educators believed in the 1950s and 1960s that students raised on television and popular music were "radically" different than their predecessors, leading schools to change the way students were taught); Bell, *supra* note 5 (educators in the 1930s were concerned that radio was destroying students' ability to pay attention and do their homework); *supra* p. 243; *supra* note 5.

19 CUBAN, TEACHERS AND MACHINES, *supra* note 16, at 11; *see* TODD OPPENHEIMER, THE FLICKERING MIND: SAVING EDUCATION FROM THE FALSE PROMISE OF TECHNOLOGY 3 (2004) (Edison said, "In ten years textbooks as the principle medium of teaching will be as obsolete as the horse and carriage are now. . . . There is no limitation to [what] the camera [can do]").

20 *See infra* Section III.C.

21 MOOC stands for "Massive Open Online Course." *See* CUBAN, TEACHERS AND MACHINES, *supra* note 16, at 19; Robert A. Reiser, *A History of Instructional Design and Technology: Part I: A History of Instructional Media*, 49 EDUC. TECH. RES. & DEV. 53, 56 (2001) (a spokesman for the National Educational Association said in 1932 that "film and radio will be as common as the book and powerful in their effect on learning and teaching").

22 *See* CUBAN, TEACHERS AND MACHINES, *supra* note 16, at 42; Bennett & Maton, *supra* note 3, at 328 (educators in the 1950s and 1960s believed that children immersed in a culture of television and popular music had developed fundamentally different learning needs); *see also supra* p. 243; *supra* note 5.

23 *See* CUBAN, TEACHERS AND MACHINES, *supra* note 16, at 17, 25–26, 33, 38, 109; CUBAN, OVERSOLD AND UNDERUSED, *supra* note 17, at 133, 138, 189; OPPENHEIMER, *supra* note 19, at 5 (the proliferation of classroom film and TV equipment in the 1960s and 1970s far outpaced student achievement); JOHN PALFREY & URS GASSER, BORN DIGITAL: UNDERSTANDING THE FIRST GENERATION OF DIGITAL NATIVES 250 (2008) (television did not transform education and neither will the Internet); Reiser, *supra* note

like a sure thing at the time since film was likely perceived to be just as revolutionary back then as the Internet is today. Yet more than one hundred years later and after several attempts to replace textbooks with "visual" technologies, books remain the most popular and effective classroom technology we have.[24] Education-by-radio must have also seemed like a surefire way to use new technology to bring the world's best teachers to underserved classrooms, yet it failed as well.[25] Perhaps that makes it less surprising that only a few years after the first MOOCs launched, Silicon Valley entrepreneur Sebastian Thrun, widely considered the "Godfather" of this technology, conceded that his "overhyped" invention was also a failure.[26] In his words, MOOCs do not work because they are a "lousy" product that cannot substitute for the individualized, face-to-face attention most students need to learn.[27]

One educational technology historian notes that many of the "overhyped and overfunded and overvalued" classroom technologies being marketed today are, like MOOCs, the same recycled ideas that already failed at least once before during the

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21, at 58 (by the mid-1960s, much of the interest in instructional television was over).

Regarding fears that technology is changing the way students think and learn, requiring a corresponding change in the way we teach, see WOLF, *supra* note 5, at 210 (neuroscientist notes that reading pedagogy has not changed much since the ancient Sumerians invented reading and writing more than 5000 years ago because the most important teaching principles are "as old as written language itself"); Christakis, *supra* note 5, at 203; Csikszentmihalyi, *supra* note 5, at 374; *see also* DURHAM STUDY, *infra* note 228, at 20 (based on meta-analysis of thousands of independent studies from around the world researchers found no evidence that the Internet has changed the way students learn); *see also supra* p. 243; *supra* note 5; *infra* pp. 268–69 and accompanying notes.

24 Palfrey, *supra* note 7, at 106 (textbooks are still used at Harvard Law School because they are an effective way to communicate information to students); *see infra* Section III.D.

25 *See* CUBAN, TEACHERS AND MACHINES, *supra* note 16, at 25–26; WATTERS, *supra* note 16, at 27.

26 WATTERS, *supra* note 16, at 35; Carmel DeAmicis, *A Q&A with "Godfather of MOOCs" Sebastian Thrun After He Disavowed His Godchild*, PANDO (May 12, 2014), http://pando.com/2014/05/12/a-qa-with-godfather-of-moocs-sebastian-thrun-after-he-disavowed-his-godchild/ [http://perma.cc/QR7Q-GX7T] (Thrun disowned MOOCs saying, "[W]e don't educate people as others wished, or as I wished. We have a lousy product"); *see* Randy Best, *Have MOOCs Helped or Hurt?*, INSIDE HIGHER ED. (Jan. 9, 2015), https://www.insidehighered.com/views/2015/01/09/essay-ways-moocs-helped-and-hurt-debates-about-future-higher-education [http://perma.cc/3DJE-UWUM]. A 2014 study by the University of Pennsylvania Graduate School of Education found that only 4% of students who registered for MOOCs completed them. One of the reasons proffered for why MOOCs have such an abysmal retention rate is that many are free of charge; presumably, courses that students must pay to attend have better retention rates. *Id.*

27 DeAmicis, *supra* note 26; *see* Rebecca Schuman, *The King of MOOCs Abdicates the Throne: Sebastian Thrun and Udacity's "Pivot" Toward Corporate Training*, SLATE (Nov. 19, 2013, 11:43 AM), http://www.slate.com/articles/life/education/2013/11/sebastian_thrun_and_udacity_distance_learning_is_unsuccessful_for_most_students.html [http://perma.cc/Z69F-S7HP].

last Dot Com boom.[28] Professor Karl Maton, a scholar of educational sociology, says the tendency of educators to repeat these mistakes reflects "historical amnesia" in their inability to recall the failed experiments of the past or the mistaken assumptions about changing student learning styles that led to some of them in the first place.[29]

Stanford Professor Emeritus Larry Cuban has spent his career studying the relationship between teachers and modern classroom technology in a variety of contexts from kindergarten to universities, including Stanford and its law school.[30] His goal has been to understand why these experiments repeatedly fail so educators can better avoid making the same mistakes again.[31] What he has found is a "remarkably consistent" pattern extending over time in which classroom technology is both "oversold and underused."[32] He found a similar pattern with respect to teaching practices that he characterizes as "change amidst constancy," meaning that even when teachers adopt new technologies, they tend to do so in ways that reinforce established classroom practices rather than change them.[33]

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28 *See* WATTERS, *supra* note 16, at 15. Some of the educational technology products introduced during the first Dot Com boom like AllLearn and Fathom were backed by a consortium of the nation's most elite universities. *Id.* Ms. Watters speculates that perhaps they are not remembered today because of the shame associated with their failure. *Id.* at 17–18.

29 Bennett & Maton, *supra* note 3, at 328; *see* WATTERS, *supra* note 16, at 34; Lawrence A. Cunningham, *Digital Evolution in Law School Course Books*, *in* LEGAL EDUCATION IN THE DIGITAL AGE 81, 95–96, 100 (Edward Rubin ed., 2012) ("[P]lus ca change, plus c'est la meme chose" [sic]; several contemporary trends in law school pedagogy like "skills training" and "storytelling" are merely recycled ideas from past).

30 *See* CUBAN, OVERSOLD AND UNDERUSED, *supra* note 17, at 107, 127, 137–39, CUBAN, TEACHERS AND MACHINES, *supra* note 16, *passim*.

31 *See* CUBAN, OVERSOLD AND UNDERUSED, *supra* note 17, at 19; CUBAN, TEACHERS AND MACHINES, *supra* note 16, at 109.

32 *See* CUBAN, OVERSOLD AND UNDERUSED, *supra* note 17, at 137, 171, 195.

33 CUBAN, TEACHERS AND MACHINES, *supra* note 16, at 50, 63–65, 109; *see* CUBAN, OVERSOLD AND UNDERUSED, *supra* note 17, at 129–30, 195–96; WATTERS, *supra* note 16, at 27, 37 (educators conflate the adoption of new teaching tools with new ideas when in fact new technologies are most often used "to do the same old stuff"); Cunningham, *supra* note 29, at 100 (with respect to innovations in legal education, "plus ca change, plus c'est la meme chose" [sic]); Jake New, *Professors Say Technology Helps in Logistics, Not Learning,* CHRON. HIGHER ED. (Jan. 28, 2013), http://chronicle.com/blogs/wiredcampus/professors-say-technology-helps-in-logistics-rather-than-in-learning/41777 [http://perma.cc/2EE7-KM XL] (classroom technology mostly used as a management tool; little to no indication it is used for truly innovative pedagogy); *see also* Noel Enyedy, *New Interest, Old Rhetoric, Limited Results, and the Need for a New Direction for Computer-Mediated Learning*, NAT'L EDUC. POL'Y CTR., U. COLO. BOULDER (Nov. 2014), http://nepc.colorado.edu/publication/personalized-instruction [http://perma.cc/EF6Q-WZ8T] (with respect to secondary school education, more than 30 years after computers were first placed in classrooms, they are now commonplace; yet teaching practices and learning outcomes still look the same).

Professor Cuban has identified several reasons why these patterns persist.[34] A few may no longer apply due to differences between today's digital technologies and the analog ones he studied many years ago regarding their ease of use and flexibility.[35] On the other hand, his conclusion that classroom technology has been historically underused because administrators hastily invest in it without first consulting teachers still holds true today.[36] For instance, Professor John Palfrey describes how administrators at Harvard Law School did exactly that in the 1990s when, like many other law school administrators at the time, they unilaterally decided to put Internet connections in every classroom.[37] Once the faculty figured out students were using the Internet during class to surf the web instead of learn, they ordered the connections removed.[38]

Administrators feel a great sense of urgency to adopt new technologies because of the public perception that if a school is not doing so, it is falling behind.[39] New technology also generates its own hype, which creates even more pressure to adopt it now and ask questions later.[40] Professor Cuban observes that high

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34 *See* CUBAN, TEACHERS AND MACHINES, *supra* note 16, at 104; WATTERS, *supra* note 16, at 16–22 (even the use of classroom computers today reflect the same patterns associated with earlier experiments in the 1960s with a platform called PLATO, and again during the first Dot Com boom with AllLearn and Fathom).

Professor Cuban recently acknowledged on his blog that digital technologies are now much more widely adopted and used more frequently than the analog technologies he has studied in the past. Larry Cuban, *Using Technology to Nail Down What We Know and Don't Know About Effects of High-Tech on People Today,* LARRY CUBAN ON SCH. REFORM & CLASSROOM PRAC. (Jan. 27, 2014, 1:00 AM), https://larrycuban.wordpress.com/2014/01/27/using-technology-to-nail-down-what-we-know-and-dont-know-about-effects-of-high-tech-on-people-today/ [https://perma.cc/B53L-TTWB] [hereinafter Cuban, *Using Technology to Nail Down What We Know*]. In all other respects, however, Professor Cuban asserts that his original conclusions still obtain. *Id.*

35 *See* CUBAN, TEACHERS AND MACHINES, *supra* note 16, at 18, 52–53. *But see* Simon Canick, *Infusing Technology Skills into the Law School Curriculum*, 42 CAP. U. L. REV. 663, 676 (2014) (noting that legal educators reject digital technologies because they have difficulty using them, and due to issues with reliability, amongst other reasons).

36 *See* CUBAN, OVERSOLD AND UNDERUSED, *supra* note 17, at 137, 158; PALFREY & GASSER, *supra* note 23, at 238; CUBAN, TEACHERS AND MACHINES, *supra* note 16, at 36.

37 PALFREY & GASSER, *supra* note 23, at 237–38.

38 *Id.*; Palfrey, *supra* note 7, at 107–08.

39 *See* CUBAN, OVERSOLD AND UNDERUSED, *supra* note 17, at 158; CUBAN, TEACHERS AND MACHINES, *supra* note 16, at 76–77; Bennett & Maton, *supra* note 3, at 321; Larry Cuban, *Does Online Instruction Work? (Part 3)*, LARRY CUBAN ON SCH. REFORM & CLASSROOM PRAC. (June 7, 2013, 1:00 AM), https://larrycuban.wordpress.com/2013/06/07/does-online-instruction-work-part-3/ [https://perma.cc/WTC3-N8US] [hereinafter Cuban, *Does Online Instruction Work?-3*]; Larry Cuban, *The Lack of Evidence-Based Practice–The Case of Classroom Technology (Part 2)*, LARRY CUBAN ON SCH. REFORM & CLASSROOM PRAC. (Feb. 9, 2015, 1:00 AM), https://larrycuban.wordpress.com/2015/02/09/the-lack-of-evidence-based-practice-the-case-of-classroom-technology-part-2/ [https://perma.cc/K94F-3YAG] [hereinafter Cuban, *The Lack of Evidence Based Practice-2*].

40 *See, e.g.*, Issie Lapowsky, *What Schools Must Learn from LA's iPad Debacle*,

tech carries great symbolism in the public's mind and, like high fashion, "conveys a whiff of superiority" compared to schools that do not have it.[41] By investing in new technology, a school creates the perception of innovative teaching because the public easily conflates the two.[42] In practice, however, Professor Cuban finds that technology, with rare exceptions, is used in ways that maintain conventional teaching practices rather than change them.[43]

Pressure to innovate means that administrators invest in new technology before a need is identified or teachers have even had a chance to figure out whether or how to use it.[44] Thus, technology often becomes a solution in search of a problem, which further explains Professor Cuban's paradoxical conclusion that it is "oversold" yet "underused."[45]

Of course, whenever a new classroom technology is first introduced, no research yet exists on its effectiveness or whether it is even compatible with the way students learn.[46] But because educators feel so much pressure to show they are keeping up with the times, they are either unable or unwilling to wait for that research to be done, so they forge ahead anyway based on intuition and "common sense."[47]

Once the technology is paid for and in place, confirmation bias helps validate belief in the correctness of the original

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WIRED (May 8, 2015, 7:00 AM), http://www.wired.com/2015/05/los-angeles-edtech/ [http://perma.cc/W2T2-DM6F] (Los Angeles Unified School District's aborted $1.3 billion agreement to buy every student an iPad "is a classic case of . . . getting caught up in the ed tech frenzy" over a new device before administrators had taken the time to understand it).

41 *See* CUBAN, OVERSOLD AND UNDERUSED, *supra* note 17, at 158–59; Cuban, *Does Online Instruction Work?-3*, *supra* note 39.

42 *See* CUBAN, OVERSOLD AND UNDERUSED, *supra* note 17, at 158–59; WATTERS, *supra* note 16, at 5, 27, 37; Palfrey, *supra* note 7, at 109 (spending money on technology helps a law school burnish its reputation, even if the hardware sits unused while the faculty figures out what to do with it); Cuban, *Does Online Instruction Work?-3, supra* note 39.

43 *See* CUBAN, OVERSOLD AND UNDERUSED, *supra* note 17, at 134, 156, 170, 196; *see also supra* note 33.

44 *See* Cuban, *Does Online Instruction- Work?-3, supra* note 39; PALFREY & GASSER, *supra* note 23, at 238 (law schools at every level have done what Harvard did in the late 1990s, which is to spend thousands of dollars on new classroom technologies that remain unused while the faculty decides what to do with them).

45 *See* CUBAN, OVERSOLD AND UNDERUSED, *supra* note 17, at 139; PALFREY & GASSER, *supra* note 23, at 238.

46 Cuban, *Does Online Instruction Work?-3*, *supra* note 39.

47 *Id.*; Cuban, *The Lack of Evidence-Based Practice-2*, *supra* note 39 (in the absence of research, educators adopt new technology because of the high value the public places on it, pressure to appear current, and the fear of negative perceptions if they don't); *see also* DEHAENE, *supra* note 7, at 327 (educational decisions are often grounded in well-meaning ideologies but in the absence of rational thought, these intuitive judgments become largely misguided teaching practices).

decision since educators see with their own eyes how technology is influencing the lives of those around them and the culture at large.[48] So what began as assumption and intuition is soon treated by all as fact.[49] And the more these assumptions are repeated, their credibility is undeservedly enhanced due to a phenomenon called the "illusion of truth."[50] This further discourages skepticism and critical review of the underlying beliefs which allows them to proliferate even more.[51]

Professor Maton describes a "certainty-complacency spiral" among scholars in which stereotypes about digital natives circulate in the literature without challenge.[52] The only support these authors provide are references to other authors making the same unsubstantiated claims.[53] For example, the assertion that all digital natives are tech savvy is widely accepted as true, even though the data says otherwise.[54]

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48 Bennett et al., *supra* note 3, at 779 (though many claims about digital natives appeal to common sense, they lack empirical support); Cuban, *Does Online Instruction Work?-3*, *supra* note 39; *see* DANIEL WILLINGHAM, WHY DON'T STUDENTS LIKE SCHOOL?: A COGNITIVE SCIENTIST ANSWERS QUESTIONS ABOUT HOW THE MIND WORKS AND WHAT IT MEANS FOR YOUR CLASSROOM 121 (2009) [hereinafter WILLINGHAM, WHY DON'T STUDENTS LIKE SCHOOL] (confirmation bias turns the intuitive beliefs educators hold about how students learn into firmly held views).

49 Bennett & Maton, *supra* note 3, at 328; *see* DEHAENE, *supra* note 7, at 327 (intuition should not replace carefully accumulated scientific knowledge); ROBERT SYLWESTER, A CELEBRATION OF NEURONS: AN EDUCATOR'S GUIDE TO THE HUMAN BRAIN 54 (1995) (intuition about how students learn leads to mistakes, overgeneralizations, and stereotypes).

50 *See* Haun, *supra* note 3, at 293 (the "illusion-of-truth" effect is a well-documented psychological phenomenon in which people conflate the frequency with which a statement is repeated with its veracity); Lynn Hasher et al., *Frequency and the Conference of Referential Validity*, 16 J. VERBAL LEARNING & VERBAL BEHAV. 107, 111 (1977) (studies show that merely repeating a statement over and over increases the listener's belief in its truth); Jeremy Dean, *The Illusion of Truth,* PSYBLOG (Dec. 8, 2010), http://www.spring.org.uk/2010/12/the-illusion-of-truth.php [http://perma.cc/9GTR-6FUK] (one of the simplest, most effective persuasive techniques is to keep repeating a statement because the brain equates familiarity with truth).

51 *See* Bennett et al., *supra* note 3, at 783; *see also* Cuban, *Does Online Instruction Work?-3*, *supra* note 39.

52 Bennett & Maton, *supra* note 3, at 328.

53 *Id.*

54 Educators incorrectly assume digital natives are tech savvy because they conflate fluency with proficiency. *See id.* at 324 (surveys find many digital natives are not knowledgeable about Web 2.0 tools, do not create content, do little gaming, and instead use the Internet mostly for social activity); Jones & Shao, *supra* note 4, at 34; Lai & Hong, *supra* note 1, at 735 (no difference between digital natives and immigrants in their use of technology); Penny Thompson, *The Digital Natives as Learners: Technology Use Patterns and Approaches to Learning*, 65 COMPUTERS & EDUC. 12, 20, 23 (2013) (surveys show college students have limited proficiency with a small number of devices that get used for a narrow range of activities like socializing, gaming, and surfing the web); Shiang-Kwei Wang et al., *An Investigation of Middle School Science Teachers and Students Use of Technology Inside and Outside of Classrooms: Considering Whether Digital Natives Are More Technology Savvy than Their Teachers*, 62 EDUC. TECH. RES. & DEV. 637, 643, 655

It is only later, when classroom technology fails to work as promised, or the unintended consequences come to light, that some may question the wisdom of the original decision.[55] It has been happening for years in legal education with the backlash against classroom laptops that were first touted as necessary to accommodate the new, "multitasking learning style" of digital natives.[56] It is consistent with, and indeed predicted by, Professor Cuban's work, as he finds that teachers typically stop using a new technology once the initial hype subsides and they realize that a supposedly "revolutionary" tool is actually less effective than the one it replaced.[57]

At the classroom level, Professor Cuban finds that historical patterns show teachers are generally pragmatic; they adopt new technology when it helps solve a problem not addressed by existing solutions.[58] Otherwise they tend to stick with what is already working, which is why they are frequently criticized for being resistant to change and stuck in the past.[59] Teachers also have a track record of rejecting new technology when they believe it will interfere with student classroom rapport, a concern expressed by some law professors about digital technologies as well.[60] On the other hand, they routinely embrace it if they think it will help them motivate students to learn.[61] And though a

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(2014) (study of more than 1000 New York and Utah high school students finds they are no more tech savvy than their teachers); Megan O'Neil, *Confronting the Myth of the 'Digital Native,'* CHRON. HIGHER EDUC. (Apr. 21, 2014), http://chronicle.com/article/Confronting-the-Myth-of-the/145949/ [http://perma.cc/S5L8-CN8Z] (observing that the assumption today's students are tech savvy is a myth).

55 *See* CUBAN, OVERSOLD AND UNDERUSED, *supra* note 17, at 132–33.

56 *See* Paul L. Caron & Rafael Gely, *Taking Back the Law School Classroom: Using Technology to Foster Active Student Learning*, 54 J. LEGAL EDUC. 551, 555–58 (2004) (noting criticism by law professors of the "unbridled use" of PowerPoint and laptops because of their negative effect on learning); Eric A. DeGroff, *The Dynamics of the Contemporary Law School Classroom: Looking at Laptops Through a Learning Style Lens*, 39 U. DAYTON L. REV. 201, 208–10 (2014) (describing backlash by law professors against classroom laptops); Maxwell, *infra* note 60, at 4; Palfrey, *supra* note 7, at 107–08.

57 *See* CUBAN, TEACHERS AND MACHINES, *supra* note 16, at 54; Palfrey, *supra* note 7, at 107 (when it comes to the use of classroom technology in law school, we tend to lurch ahead into the future, retreat and then, perhaps, advance again).

58 *See* CUBAN, OVERSOLD AND UNDERUSED, *supra* note 17, at 167–68; CUBAN, TEACHERS AND MACHINES, *supra* note 16, at 66; *see also infra* Section III.A.

59 *See* CUBAN, OVERSOLD AND UNDERUSED, *supra* note 17, at 140; CUBAN, TEACHERS AND MACHINES, *supra* note 16, at 58; *see also* SULLIVAN ET AL., *supra* note 11, at 89–91 (noting legal educators are persistently criticized for being stuck in the past).

60 *See* CUBAN, OVERSOLD AND UNDERUSED, *supra* note 17, at 169; CUBAN, TEACHERS AND MACHINES, *supra* note 16, at 61, 88–90; Caron & Gely, *supra* note 56, at 558; Nancy G. Maxwell, *From Facebook to Folsom Prison Blues: How Banning Laptops in the Classroom Made Me a Better Law School Teacher,* 14 RICH. J.L. & TECH. 1, 4–5 (2007) (discussing the negative effect of laptops on student-teacher classroom rapport in law school); *infra* p. 290 and accompanying notes.

61 *See* CUBAN, TEACHERS AND MACHINES, *supra* note 16, at 68.

connection between new technology and better student engagement is widely assumed, one of the largest meta-studies to date on the effectiveness of digital classroom tools found no evidence to support that belief.[62]

In sum, the history of classroom technology shows that pressure to innovate mixed with intuition and assumptions about changing student learning styles can often be a toxic combination.[63] Yet legal educators today face even more pressure to "innovate" as schools compete for a shrinking pool of applicants while they also struggle to figure out how best to train students for the challenging job market ahead. Throwing more technology at these issues at least *seems* like a good solution because it carries many of the right connotations. But unlike classroom experiments of the past, there is substantial evidence that digital technologies in particular can make things worse by lowering student learning outcomes.[64] Avoiding that means ignoring the stereotypes about how digital natives learn best and looking instead to learning science to better inform our classroom practices.[65]

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62 *See infra* p. 279 and notes 237–38; *see also* Bill Ferriter, *Are Kids Really Motivated by Technology?*, LARRY CUBAN ON SCH. REFORM & CLASSROOM PRAC. (Sept. 2, 2012), https://larrycuban.wordpress.com/2012/09/02/are-kids-really-motivated-by-technology-bill-ferriter/ [https://perma.cc/76VB-WHTJ] (the claim technology motivates students in ways that demonstratively improve learning is a red herring).

63 CUBAN, TEACHERS AND MACHINES, *supra* note 16, at 102–03 (overselling technology together with unexamined assumptions and unanticipated consequences does not yield good results); Larry Cuban, *FAQs for a Skeptic on Technology*, LARRY CUBAN ON SCH. REFORM & CLASSROOM PRAC. (Aug. 16, 2012) [hereinafter Cuban, *FAQs for a Skeptic*], https://larrycuban.wordpress.com/2012/08/16/faqs-for-a-skeptic-on-technology/ [https://perma.cc/ZB2D-FPDX]; *see* CAREY, *supra* note 7, at 214 (educators do not have good instincts about how students learn); *infra* pp. 277–78 and accompanying notes.

64 *See* Shahid Alvi, *Proceed with Caution: Technology Fetishism and the Millennial Generation*, 8 INTERACTIVE TECH. & SMART EDUC. 135, 136–37 (2011) (we should be cautious in using digital technologies because they can cause more harm than good); *infra* Section III.B–E.

65 "Learning science" is not a perfect solution either because the insights gained by researchers working in a lab under controlled conditions do not always translate to the realities of the classroom. *See* DEHAENE, *supra* note 7, at 218, 326–27 (though a gap separates knowledge gained in the lab from the classroom, we cannot detach the two; neuroscience sheds indispensable light on how the brain works in ways that can benefit educators); WILLINGHAM, WHY DON'T STUDENTS LIKE SCHOOL, *supra* note 48, at 1; Palfrey, *supra* note 7, at 122–23. Nevertheless it adds an important element of objectivity to a decision-making process that is too frequently informed solely by assumptions and observations about the changing technology habits of our students.

II. "CAVEMAN NO FOOL!": WHAT LEARNING SCIENCE CAN TELL US ABOUT HOW THE BRAIN WORKS[66]

To a cognitive scientist, the brain is merely an information processing machine designed to solve whatever problems stand between it and survival.[67] It does that by comparing the problem at hand to similar ones it has faced in the past.[68] Those past experiences consist of sensory data, normally called "memories," that are stored in nerve cells, or neurons, comprising the brain's cerebral cortex.[69] Learning is the process by which these neurons band together, usually through repetition and effort, to form the neural pathways that reflect the underlying experience.[70] In simple terms, "thinking" is about solving problems the brain has seen before based on pattern recognition.[71]

We use the Socratic Method, for instance, to help students build the pattern recognition tools, also known as schemas, they need to issue spot, analyze, and read cases like a lawyer.[72] How the brain constructs these schemas has not changed much in 50,000 years.[73] The mistake legal educators make is conflating

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66 *See* THE CRAMPS, *Caveman*, *on* PSYCHEDELIC JUNGLE (I.R.S. Records 1981) ("Uh, look man, make tool! Caveman no fool!").

67 *See* JOHN MEDINA, BRAIN RULES: 12 PRINCIPLES FOR SURVIVING AND THRIVING AT WORK, HOME, AND SCHOOL 32 (2008); PINKER, HOW THE MIND WORKS, *supra* note 10, at 182, 210.

68 DUANE F. SHELL ET AL., THE UNIFIED LEARNING MODEL: HOW MOTIVATIONAL, COGNITIVE, AND NEUROBIOLOGICAL SCIENCES INFORM BEST TEACHING PRACTICES 12, 22, 25–26 (2010).

69 *See* CAREY, *supra* note 7, at 6, 14–15; SHELL ET AL., *supra* note 68, at 10, 13 (cerebral cortex consists of outermost layers of brain responsible for all experiences, perception, emotions, thought and problem solving).

70 *See* CAREY, *supra* note 7, at 94 (learning requires practice and effort; the more difficult the practice, the greater the benefits); SCHANK, TEACHING MINDS, *supra* note 20, at 177; SHELL ET AL., *supra* note 68, at 14, 24–27, 55, 144–45; WILLINGHAM, WHY DON'T STUDENTS LIKE SCHOOL, *supra* note 48, at 131, 142–43 (learning takes hard work and practice).

71 *See* DAVIS, *supra* note 9, at 27; DANIEL KAHNEMAN, THINKING, FAST AND SLOW 115 (2011); SCHANK, TEACHING MINDS, *supra* note 14, at 135; SHELL ET AL., *supra* note 68, at 12, 22, 54, 56, 77; WILLINGHAM, WHY DON'T STUDENTS LIKE SCHOOL, *supra* note 48, at 29, 86–91.

72 *See* SHELL ET AL., *supra* note 68, at 13; SYLWESTER, *supra* note 49, at 50, 57; WILLINGHAM, WHY DON'T STUDENTS LIKE SCHOOL, *supra* note 48, at 101.

73 *See* DAVIS, *supra* note 9, at 33–40; PINKER, HOW THE MIND WORKS, *supra* note 10, at 34; *supra* p. 243 and note 9; *infra* pp. 265–69 and accompanying notes. Very recently, however, some experts have made the case that human evolution, including genetic changes that affect the brain, might occur in as little as twenty-five generations. *See* Bolhuis et al., *supra* note 9, at 2 (recent research suggests that man-made environmental changes have yielded corresponding genetic, evolutionary changes within the last 10,000 years and that these could occur in as quickly as a few hundred years). Nonetheless, in the extensive research I did for this Article, I found no empirical support for the claim that the brain, or the way we think and learn, has undergone change in the past thirty years due to the pervasive use of technology. *See infra* pp. 265–69 and accompanying notes. To the contrary, the evidence points decidedly in the other direction. *See infra*

observations about our students' changing technology habits with changes in the cognitive processes that control learning.[74] However, it is the cognitive processes we cannot see, because they occur inside the brain, that are the most important aspects of learning to understand in assessing the compatibility of our classroom methods with the outcomes we seek. The following is a basic overview.[75]

A. Did I Mention the Importance of Attention?

Learning starts by attending to our experiences, which enter the brain as raw sensory data.[76] The amount of data flowing into the brain at any given moment is overwhelming.[77] Consider attending to every sight and sound in your immediate vicinity, including an awareness of your own breathing and every sensation upon your skin.[78] The brain has nowhere near the processing capacity to handle all that.[79] Nor would it have served any evolutionary imperative since the brain only needs enough processing power to solve whatever problem stands between it and survival.[80] Contrary to popular belief, evolution does not favor a big, "smart" brain with lots of computing power.[81] Rather, it favors the smallest, dumbest one for the job, which is the one we got.[82]

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pp. 267–68, notes 162–63.

74 *See supra* p. 252 and accompanying notes.

75 In attempting to provide the reader with a helpful and concise summary of how the brain learns—an organ that scientists tell us is the most complex structure in the known universe and about which we understand only a small fraction of the mysteries that remain—there is a risk of overgeneralizing explanations and some very nuanced material. I have tried to avoid that by sticking to the basics about which a general consensus exists among experts. To the extent my research revealed otherwise, I have so indicated.

76 *See* WINIFRED GALLAGHER, RAPT: ATTENTION AND THE FOCUSED LIFE 25, 146, 163 (2010); JOHN J. RATEY, A USER'S GUIDE TO THE BRAIN 185–95 (2001).

77 *See* DAVIS, *supra* note 9, at 27; GALLAGHER, *supra* note 76, at 9 (because we are bombarded with so much stimuli, the function of attention is to distill the universe for us); RATEY, *supra* note 76, at 108; SHELL ET AL., *supra* note 68, at 13; SYLWESTER, *supra* note 49, at 57, 79.

78 *See* GALLAGHER, *supra* note 76, at 9; RATEY, *supra* note 76, at 108; SHELL ET AL., *supra* note 68, at 13; SYLWESTER, *supra* note 49, at 50, 57.

79 *See* GALLAGHER, *supra* note 76, at 9; SHELL ET AL., *supra* note 68, at 11, 13; SYLWESTER, *supra* note 49, at 50, 57.

80 *See* MEDINA *supra* note 67, at 32; *supra* p. 255 and note 67.

81 *See* PINKER, HOW THE MIND WORKS, *supra* note 10, at 152–55.

82 *Id.* at 151–55; PETER J. RICHERSON & ROBERT BOYD, NOT BY GENES ALONE: HOW CULTURE TRANSFORMED HUMAN EVOLUTION 135 (2005) (creatures are engineered to be as stupid as possible but still survive); WILLINGHAM, WHY DON'T STUDENTS LIKE SCHOOL, *supra* note 47, at 3 (contrary to popular belief, the brain is not designed for thinking but to *save us* from having to think at all).

Attention serves the key role of allocating the brain's limited processing capabilities between competing stimuli.[83] A function called "working memory" handles the task by deciding what information to ignore, what gets momentary attention, and what merits further consideration such that it might eventually become "learned."[84] This makes working memory the gatekeeper of all learning.[85]

It does this by directing attention either toward or away from stimuli based on an emotional assessment of its meaningfulness.[86] Sometimes this happens below the level of consciousness while other times we are acutely aware of it, such as "look out for that saber-toothed tiger!" or "I better pay attention because this might be on the exam!"[87] Information captures our attention either because it is intrinsically meaningful, e.g., the smell of a savory meal on an empty stomach, or because it relates to an extrinsic goal or interest, such as earning a good grade at semester's end.[88] Extrinsic goals typically require more effort and motivation to maintain our attention than intrinsic ones.[89]

While unimportant information is ignored altogether, a function called "short-term memory" holds it only for as long as needed to complete the task at hand, like remembering a telephone number.[90] Short-term memory is how the brain handles most of the routine tasks of daily life. Once the task is done, the information is deleted, reflecting an evolutionary adaptation designed to conserve working memory's limited processing capabilities in much the same way a computer's RAM drive deletes data to free-up processing space.[91] For teachers it

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83 *See* RATEY, *supra* note 76, at 114; SHELL ET AL., *supra* note 68, at 22–23; SYLWESTER, *supra* note 49, at 78.

84 *See* RATEY, *supra* note 76, at 185–95; SHELL ET AL., *supra* note 68, at 20–21.

85 *See* SHELL ET AL., *supra* note 68, at 13; WILLINGHAM, WHY DON'T STUDENTS LIKE SCHOOL, *supra* note 47, at 83, 86 (working memory is the place in the brain where "thinking" happens).

86 *See* MEDINA *supra* note 67, at 79–83; PINKER, HOW THE MIND WORKS, *supra* note 10, at 143, 373; RATEY, *supra* note 76, at 114–15, 120–21, 248; SHELL ET AL., *supra* note 68, at 56; SYLWESTER, *supra* note 49, at 71–72.

87 *See* GALLAGHER, *supra* note 76, at 9 (paying attention means spending one's limited cognitive currency, so you should spend it wisely); MEDINA *supra* note 67, at 81; SHELL ET AL., *supra* note 68, at 69, 119, 143.

88 *See* MEDINA, *supra* note 67, at 81; SHELL ET AL., *supra* note 68, at 39, 67; SYLWESTER, *supra* note 49, at 72, 80.

89 *See* KAHNEMAN, *supra* note 71, at 41; SHELL ET AL., *supra* note 68, at 13–14.

90 *See* RATEY, *supra* note 76, at 194–95; SHELL ET AL., *supra* note 3, at 20–21; SYLWESTER, *supra* note 49, at 80, 92.

91 *See* PINKER, HOW THE MIND WORKS, *supra* note 10, at 137–39; SHELL ET AL., *supra* note 68, at 21; SYLWESTER, *supra* note 49, at 92.

means information that does not make it past students' short-term memory—either because they did not attend to it very well or their attention was interrupted—is gone and cannot be learned.[92]

More meaningful information is transferred to long-term memory, where it may be stored among the patterns, or schemas, used for thinking and problem solving.[93] To truly become "learned," however, it usually requires that the neurons comprising the relevant pathways be fired again and again through practice and effort to reinforce and strengthen them.[94] The more this is rehearsed, the better able the brain is to retrieve that information later.[95]

Significantly, information processed into long-term memory is typically not stored within a single grouping of neural pathways but among several of them devoted to separate aspects of the experience.[96] It will also be wired together with existing pathways related to similar, past experiences.[97] For example, sensory data associated with the previously mentioned savory meal will be stored in separate neural pathways relating to its taste, color, and smell.[98] Though each network is separate, they are all linked together in a chain.[99] Later thinking about that food activates all the pathways in the chain, which working memory assembles into a cohesive thought in the mind's eye.[100] Even thinking about a single aspect of the experience, like the food's taste or smell, may activate the other pathways as well.[101] This is the rationale underlying multimodal learning theory, which posits that instructional methods appealing to multiple senses may encode information more diversely in the brain, which can later aid recall as well as contribute to the breadth of

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92 *See* KAHNEMAN, *supra* note 71, at 22–23 (interfering with attention disrupts our rational, effortful thought processes which diminishes competency); SHELL ET AL., *supra* note 68, at 23–24; WILLINGHAM, WHY DON'T STUDENTS LIKE SCHOOL, *supra* note 48, at 43.

93 *See* SHELL ET AL., *supra* note 68, at 12, 55.

94 *See* CAREY, *supra* note 7, at 94 (learning requires practice and effort; the more difficult the practice, the greater the benefits); KAHNEMAN, *supra* note 71, at 238; MEDINA, *supra* note 67, at 107; RATEY, *supra* note 76, at 36–37; SHELL ET AL., *supra* note 68, at 14, 24, 55, 144.

95 *See* SHELL ET AL., *supra* note 68, at 19, 24.

96 *See* PINKER, HOW THE MIND WORKS, *supra* note 10, at 119–20; SHELL ET AL., *supra* note 68, at 25.

97 *See* SHELL ET AL., *supra* note 68, at 12, 26 (working memory connects new experiences to neural pathways associated with similar, earlier ones).

98 *See id.* at 12–13.

99 *Id.* at 12.

100 *See id.* at 12, 26.

101 *See id.* at 12, 26, 77, 183.

pattern recognition tools available for all thinking and problem solving.[102]

To solve problems, working memory activates the neural pathways associated with similar, past experiences which can be assembled in a multitude of combinatorial ways.[103] At a neurobiological level, the difference between an expert and novice is the breadth and depth of these pattern recognition tools, which is also referred to as "background knowledge."[104] A larger database of patterns is why experts see solutions to problems that novices never will.[105] Experts are also able to solve problems more quickly than novices because they have spent more time practicing the storage and retrieval of these patterns.[106]

As working memory is the gateway to all learning, it is important to understand its limitations and constraints.[107] Cognitive scientists used to think that working memory could only process about seven bits of information at once, though that estimate has since been reduced to four.[108] It drops even more as the complexity of the task increases.[109] And learning new things, in particular, places an additional load on working memory's very limited processing capacity.[110] A technique called "chunking" allows working memory to process more information at one time by organizing it into conceptually similar groups.[111] For example,

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102 *See* MEDINA, *supra* note 67, at 208–10, 219; SHELL ET AL., *supra* note 68, at 26, 77, 183–84.

103 *See* SHELL ET AL., *supra* note 68, at 12, 26, 56; WILLINGHAM, WHY DON'T STUDENTS LIKE SCHOOL, *supra* note 48, at 11–12.

104 *See* SHELL ET AL., *supra* note 68, at 38–39, 57–58; WILLINGHAM, WHY DON'T STUDENTS LIKE SCHOOL, *supra* note 48, at 29–35, 101 ("When it comes to knowledge, those who have more gain more . . . ."). "Memory is like a spiderweb that catches new information. The more it catches, the bigger it grows. And the bigger it grows, the more it catches." JOSHUA FOER, MOONWALKING WITH EINSTEIN: THE ART AND SCIENCE OF REMEMBERING EVERYTHING 209 (2011).

105 *See* KAHNEMAN, *supra* note 71, at 90 (humans are pattern seekers); SHELL ET AL., *supra* note 68, at 57–58; WILLINGHAM, WHY DON'T STUDENTS LIKE SCHOOL, *supra* note 48, at 30, 101–02 (experts don't just have more experience than novices, it's also organized in ways that lets them see patterns others don't).

106 *See* PINKER, HOW THE MIND WORKS, *supra* note 10, at 361; SHELL ET AL., *supra* note 68, at 58; WILLINGHAM, WHY DON'T STUDENTS LIKE SCHOOL, *supra* note 48, at 30, 106–07.

107 *See* SHELL ET AL., *supra* note 68, at 13.

108 *See* FOER, *supra* note 104, at 56; SHELL ET AL., *supra* note 68, at 2, 19; Jennifer Lee et al., *The Impact of Media Multitasking on Learning*, 37 LEARNING MEDIA & TECH. 94, 95–96 (2012).

109 *See* SHELL ET AL., *supra* note 68, at 13, 19, 57; David Glenn, *Divided Attention*, CHRON. HIGHER EDUC. (Feb. 28, 2010), http://chronicle.com/article/Scholars-Turn-Their-Attention/63746/ [http://perma.cc/5V22-KZ6V] (the brain is designed to let us "walk and chew gum at the same time, but not walk, chew gum, play Frisbee, and solve calculus problems").

110 *See* Lee et al., *supra* note 108, at 96.

111 *See* FOER, *supra* note 104, at 61; SHELL ET AL., *supra* note 68, at 27–28, 40–42;

trying to remember the ten random digits comprising a typical telephone number over-taxes most people's working memory, but by grouping them according to area code, exchange, and subscriber number, working memory treats those ten bits of information as three, which most people can process.[112]

By comparison, working memory's ability to attend to more than one task at a time is even more tightly constrained. In truth, it does not exist because it is basically impossible for the brain to "multitask" beyond activities that are so automated, like walking and chewing gum at the same time, that they require no attention.[113] So, what looks like multitasking to the casual observer is actually "task-switching."[114] Studies show that students who move back and forth between tasks take more time to complete each one and both are performed with much less proficiency.[115]

When educators first saw students multitasking in class, many assumed it was a new learning style resulting from constant exposure to digital technology.[116] But seeing it through the lens of learning science shows it instead to be a maladaptive learning behavior.[117] In describing the results of a leading research study on the effects of multitasking on the brain, one of its authors, Stanford Professor Clifford Nass, observed: "We were

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WILLINGHAM, WHY DON'T STUDENTS LIKE SCHOOL, *supra* note 48, at 26.

112 *See* FOER, *supra* note 104, at 61; SHELL ET AL., *supra* note 68, at 27–28.

113 *See* GALLAGHER, *supra* note 76, at 152; DANIEL J. LEVITIN, THE ORGANIZED MIND: THINKING STRAIGHT IN THE AGE OF INFORMATION OVERLOAD 16, 96 (2014); MEDINA, *supra* note 67, at 85; SHELL ET AL., *supra* note 68, at 56–58 (to the extent any task requires attention, we can only perform one at a time; everything else is task switching); SYLWESTER, *supra* note 49, at 81. *See generally* Eyal Ophir et al., *Cognitive Control in Media Multitaskers*, 106 PROC. NAT'L ACAD. SCI. U.S. 15583 (2009) (study widely cited for the proposition that the ability to multitask does not exist); *infra* p. 261 and note 118; *infra* p. 267 and notes 162–63.

114 *See* GALLAGHER, *supra* note 76, at 152; SHELL ET AL., *supra* note 68, at 21, 58.

115 As discussed in Part III, there is a robust body of evidence showing that students who task-switch during class learn less and perform more poorly on tests, in some cases significantly so, compared to unitaskers. *See* GALLAGHER, *supra* note 76, at 153; MEDINA, *supra* note 67, at 84 (a person interrupted in a task can take up to fifty times longer to complete it); POWERS, *supra* note 5, at 59 (one minute of interruption requires fifteen minutes of recovery time); Lee et al., *supra* note 108, at 102 ("[M]ultitasking interferes with knowledge acquisition. It generates extraneous cognitive load that burdens the working memory."). *See generally* Susan M. Ravizza et al., *Non-academic Internet Use in the Classroom Is Negatively Related to Classroom Learning Regardless of Intellectual Ability*, 78 COMPUTERS & EDUC. 109 (2014) (reporting research results that are consistent with earlier studies finding a negative correlation between the use of wireless devices in class and learning).

116 *See* Glenn, *supra* note 109 (noting that some professors argue we should accommodate multitasking behaviors because "[o]ne of the basic tenets of good teaching is that you have to start where the students are").

117 *See infra* pp. 282–83 and accompanying notes.

absolutely shocked . . . . [M]ultitaskers are terrible at every aspect of multitasking. They're terrible at ignoring irrelevant information; they're terrible at keeping information in their head nicely and neatly organized; and they're terrible at switching from one task to another."[118] To dispel any remaining belief that constant exposure to technology can alter the brain by conferring multitasking superpowers, learning science suggests there are physiological and neurobiological constraints that make it impossible.[119]

All evolutionary adaptations like working memory reflect a trade-off between the needs of survival and biology.[120] Back in the day, the caveman had no need to multitask beyond walking and swinging a club at the same time.[121] Upgrading the brain's processing capabilities to confer bona fide multitasking powers would have been expensive in physiological terms.[122] The brain comprises only two percent of the body's total weight but already consumes twenty percent of its energy and nutrients.[123] If expanding working memory's ability to process information required additional brain tissue, it would have meant diverting even more bodily resources to deliver the sustenance a bigger brain would need.[124] And assuming a larger brain would also need a bigger head to contain it, childbirth would have been impossible without also killing the mother, not to mention that a bigger, bobbing head would have made the caveman more susceptible to fatal injuries in a fall.[125] That natural selection

118 *Frontline: Interview: Clifford Nass* (PBS television broadcast Dec. 1, 2009), http://www.pbs.org/wgbh/pages/frontline/digitalnation/interviews/nass.html.

119 *See* PINKER, HOW THE MIND WORKS, *supra* note 10, at 208. As Professor Pinker explains, our physiology does not evolve or change because of "needs;" we do not develop new cognitive powers because technology creates a "need" to process information more quickly or efficiently. Rather, physiological change occurs within a species as the result of random mutations that over millions of years get selected because they better serve the needs of survival. "If wishes were horses, beggars would ride." *Id.* at 206.

120 *See* MEDINA, *supra* note 67, at 41; PINKER, HOW THE MIND WORKS, *supra* note 10, at 194; RICHERSON & BOYD, *supra* note 82, at 155.

121 *See* SHELL ET AL., *supra* note 68, at 58; Glenn, *supra* note 109.

122 *See* MEDINA, *supra* note 67, at 41; PINKER, HOW THE MIND WORKS, *supra* note 10, at 138; Robin I.M. Dunbar, *Brain and Cognition in Evolutionary Perspective*, *in* EVOLUTIONARY COGNITIVE NEUROSCIENCE 21, 23 (Steven M. Platek et al. eds., 2007) (brain tissue has a high cost in evolutionary terms).

123 *See* PINKER, HOW THE MIND WORKS, *supra* note 10, at 138, 154; J. Philippe Rushton & C. Davison Ankney, *The Evolution of Brain Size and Intelligence*, *in* EVOLUTIONARY COGNITIVE NEUROSCIENCE, *supra* note 122, at 122, 150.

124 *See* PINKER, HOW THE MIND WORKS, *supra* note 10, at 138; POWERS, *supra* note 10, at 74 (expanding the attentional limits of working memory would require structural changes in the brain); Steven Pinker, *The Cognitive Niche: Coevolution of Intelligence, Sociality, and Language*, 107 PROC. NAT'L ACAD. SCI. U.S. 8993, 8995 (2010) [hereinafter Pinker, *Cognitive Niche*].

125 *See* PINKER, HOW THE MIND WORKS, *supra* note 10, at 154; Pinker, *Cognitive*

opted to give him the efficient, economy version of working memory instead of the gas-guzzling luxury model reflects an evolutionary compromise worthy of King Solomon himself, given the alternatives.

Two other aspects of attention are important to mention for purposes of this discussion. The first is that the brain is not very good at it.[126] For most of us, attention quickly starts to drift on its own after a few minutes despite our best efforts to stay on task.[127] Though this is poorly suited to many school and work related tasks associated with contemporary life, it is a trait that was highly advantageous to the caveman.[128] To survive, our nomadic, hunter-gatherer ancestors had to remain constantly alert to the presence of potential prey and threats from predators.[129] Research confirms that a caveman with ADD was a much better hunter than his buddies with stronger attentional abilities, a finding that caused one expert to quip that if Ritalin had been around back in the day, the survival of our species may have been in serious doubt.[130] But getting stuck with the same distracted brain today, however, is a distinct disadvantage to any student trying to survive their first year of law school.[131]

Niche, supra note 124, at 8995.

126 *See* CAREY, *supra* note 7, at 215, 217 (the ability to concentrate as emphasized by the contemporary model of formal schooling is a mirage that does not exist because the brain was designed to forage and avoid predators, not sit still in class); SHELL ET AL., *supra* note 68, at 13, 15, 29 (it takes effort to sustain attention for more than thirty seconds); SYLWESTER, *supra* note 49, at 120.

127 *See* GALLAGHER, *supra* note 76, at 148–49; MEDINA, *supra* note 67, at 74, 90 (research indicates that the average attention span is ten minutes, after which it typically plummets to zero); SHELL ET AL., *supra* note 68, at 13, 15, 29.

128 *See* GALLAGHER, *supra* note 76, at 17; THOM HARTMANN, BEYOND ADD: HUNTING FOR REASONS IN THE PAST AND PRESENT, at xv–xvi (1996); KAHNEMAN, *supra* note 71, at 35; Dan Eisenberg & Benjamin Campbell, *The Evolution of ADHD: Social Context Matters*, 84 S.F. MED., 21, 21–22 (Oct. 2011), http://evolution.binghamton.edu/evos/wp-content/uploads/2012/02/eisenberg-and-campbell-2011-the-evolution-of-ADHD-artice-in-SF-Medicine.pdf [http://perma.cc/3UZ3-LMGH] (studies of an isolated group in Kenya showed that traits of ADD have distinct advantages for nomadic peoples); Amanda Schaffer, *The No-Label Movement,* NEW YORKER (Oct. 2, 2013), http://www.newyorker.com/tech/elements/the-no-label-movement [http://perma.cc/JTG9-ZDJD] (clinical psychologist says symptoms of ADD such as "restlessness, constant visual scanning, and being amped up for quick and aggressive action" are all attributes of good hunters).

129 *See* Eisenberg & Campbell, *supra* note 128; Richard A. Friedman, *A Natural Fix for A.D.H.D.*, N.Y. TIMES, (Oct. 31, 2014), http://www.nytimes.com/2014/11/02/opinion/sunday/a-natural-fix-for-adhd.html?_r=0 [http://perma.cc/KT5N-LCXE] ("As hunters, [our caveman ancestors] had to adapt to an ever-changing environment where the dangers were as unpredictable as [the] next meal. . . . [H]aving a rapidly shifting but intense attention span and a taste for novelty would have proved highly advantageous in locating and securing rewards—like a mate and a nice chunk of mastodon. In short, having the profile of what we now call A.D.H.D. would have made you a Paleolithic success story.").

130 *See supra* notes 128–29.

131 *See* GALLAGHER, *supra* note 76, at 17 (the distractibility that served our forbearers so well is a big drawback for post-industrial folks living in a world with lots of unwelcome

It goes to show that everything in life truly is a matter of perspective; a cognitive trait so key to the caveman's survival is now listed in the DSM-5 as a learning disability.[132] Some cognitive scientists argue that ADD is not so much a learning disability as a reflection of how maladapted our classrooms are to the caveman brain.[133] Professor Roger Schank, a world renowned cognitive and learning science scholar, goes even further by arguing that nearly all institutional education should be overhauled to better match how and what we teach with the way the caveman brain is designed to learn.[134] Anyone who has ever seen a classroom full of young children fidget knows that the ability to pay attention does not come naturally to most, which is why educators have always treated it like a skill that must be cultivated.[135]

Related to this, the brain is also programmed to detect and seek out novelty.[136] This goes hand-in-glove with distractibility in fulfilling the Darwinian survival imperative by alerting the caveman to potential new sources of food, water, friends, and better habitats.[137] To encourage this behavior, the brain is rewarded with a pleasurable shot of dopamine, the same neurotransmitter associated with drug addiction and orgasms.[138] In his book *The Shallows: What the Internet is Doing to Our Brains*, author Nicholas Carr argues that because we are genetically engineered to seek new and novel experiences, surfing the web can easily become, if not an addiction, a compulsive habit.[139] Thus, whether checking Facebook, buying shoes on

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distractions).

132 AMERICAN PSYCHIATRIC ASSOCIATION, DIAGNOSTIC AND STATISTICAL MANUAL OF MENTAL DISORDERS 59–63 (Am. Psychiatric Ass'n ed., 5th ed. 2013) (attention deficit disorder is a recognized learning disability characterized by symptoms that include being "easily distracted by extraneous stimuli"); *see* GALLAGHER, *supra* note 76, at 17, 148, 163 (ADD is only considered a disability because modern, western society places a high value on the ability to pay attention).

133 *See* CAREY, *supra* note 7, at 215, 217 (our modern system of education mistakenly assumes it is based on how the brain works; it is not); SYLWESTER, *supra* note 49, at 71.

134 SCHANK, TEACHING MINDS, *supra* note 14, at 207–09; s*ee* PINKER, HOW THE MIND WORKS, *supra* note 10, at 302 ("Natural selection . . . did not shape us to earn good grades in science class . . . .").

135 *See* GALLAGHER, *supra* note 76, at 10 ("[F]ocus is a skill, which like any other takes discipline and effort to develop."); SYLWESTER, *supra* note 49, at 83.

136 *See* GALLAGHER, *supra* note 76, at 16; PINKER, HOW THE MIND WORKS, *supra* note 10, at 377; SHELL ET AL., *supra* note 68, at 79.

137 *See* PINKER, HOW THE MIND WORKS, *supra* note 10, at 375–77; SHELL ET AL., *supra* note 68, at 20–21 (attention is designed to alight on the new and novel); Friedman, *supra* note 129.

138 *See* LEVITIN, *supra* note 113, at 96, 101–02; RATEY, *supra* note 76, at 116–17.

139 *See* NICHOLAS CARR, THE SHALLOWS: WHAT THE INTERNET IS DOING TO OUR BRAINS 116–17, 120, 194 (2011) (every time we go on the Internet we are training our brain to be distracted); LEVITIN, *supra* note 113, at 101–02 (make no mistake—checking

Zappos, or smoking crack, each of these behaviors contributes to a bio-feedback loop in the brain that encourages more of the same.[140] The implication for teachers is that although wireless devices can be powerful learning tools, giving one to a caveman during class and then expecting him to stay on task is like buying a Prius thinking it will put the polar icecaps back. It's a noble thought, but don't hold your breath.

B. The Fantastic Plastic Machine

One of the brain's most impressive characteristics is a feature called "neural plasticity." While working memory controls the flow of information that serves as the raw material for everything we learn, neural plasticity is what builds the circuitry in the brain to support it. As the name implies, it is a flexible function that accounts for all the knowledge, skills, thoughts, and beliefs we acquire in our lifetime and why they may also change over time.[141] Insofar as any of the foregoing are shared by members of our extended social group, neural plasticity is what accounts for all human culture.[142] Indeed, a reciprocal relationship exists between the two in that inventions like the smartphone, a product of neural plasticity, may influence the culture at large which in turn may influence the thoughts and behaviors of the group members.[143]

Neural plasticity was an evolutionary adaptation that gave our ancestors the cognitive flexibility to learn the tool-making, foraging, and other skills needed to survive during a time of dramatic climate change that would have given Al Gore fits.[144] In geo-historical terms, neural plasticity is linked to the Pleistocene age, which began approximately 1.8 million years ago and lasted until about 10,000 BC.[145] It was a period characterized by several

email and Facebook are neural addictions); RATEY, *supra* note 76, at 118.

140 *See* LEVITIN, *supra* note 113, at 101–02; RATEY, *supra* note 76, at 118.

141 *See* RICHERSON & BOYD, *supra* note 82, at 64–66, 71, 145–47.

142 *See* PINKER, HOW THE MIND WORKS, *supra* note 10, at 33; HENRY PLOTKIN, NECESSARY KNOWLEDGE 231, 265 (2007); RICHERSON & BOYD, *supra* note 82, at 63, 136, 145–47, 156–61.

143 *See* PINKER, HOW THE MIND WORKS, *supra* note 10, at 33. *See generally* RICHERSON & BOYD, *supra* note 82, at 45, 113, 145–47, 156–61, 195; *supra* note 9 (discussing from a phenomenological perspective that technology, like all environmental influences, can change the content of our thoughts but not the mechanisms that create them).

144 *See* RICHERSON & BOYD, *supra* note 82, at 131–36, 146–47; *see also* Leda Cosmides & John Tooby, *Evolutionary Psychology, Moral Heuristics, and the Law*, *in* HEURISTICS AND THE LAW 181, 184–85 (Gerd Gigerenzer & Christoph Engel eds., 2006).

145 Kim Ann Zimmermann, *Pleistocene Epoch: Facts About the Last Ice Age,* LIVESCIENCE (Oct. 9, 2013, 5:51 PM), http://www.livescience.com/40311-pleistocene-epoch.html [http://perma.cc/9JLT-75PR].

rapid cycles of glacial expansion and retreat that saw many species perish.[146]

Natural selection favored those creatures with the intellectual firepower needed to figure out within their own lifetime solutions to the problems associated with survival that otherwise would have taken Darwinian evolution millions of years to sort out.[147] It was like an aftermarket bolt-on accessory that gave a few lucky critters the problem-solving ability to sprint ahead of everyone else in an evolutionary footrace where placing second meant getting turned into a fossil.[148] Thus, cognitive scientists say it is no coincidence that an increase in brain size among many mammals, including the caveman, coincides with the Pleistocene period.[149]

Despite its impressive versatility, however, neural plasticity has no more ability to change the brain's information processing architecture than software can change the hardware that runs it.[150] Students who practice multitasking might improve their typing skills, but transcending the tightly circumscribed limitations on working memory's ability to toggle between a few simple tasks at once is a bridge too far.[151] On the other hand, neither can neural plasticity fry our students' brains by making them permanently more distracted as some lay commentators

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146 *See* RICHERSON & BOYD, *supra* note 82, at 132–36.

147 *See* PINKER, HOW THE MIND WORKS, *supra* note 10, at 190; RICHERSON & BOYD, *supra* note 82, at 131–37, 146–47; Cosmides & Tooby, *supra* note 144, at 185.

148 *See* PINKER, HOW THE MIND WORKS, *supra* note 10, at 342; RICHERSON & BOYD, *supra* note 82, at 146.

149 *See* DAVIS, *supra* note 9, at 24 (stating that our ancestors' brains nearly doubled in size during this period); *supra* notes 146–48.

150 *See* RICHERSON & BOYD, *supra* note 82, at 129–31 (neural plasticity can change behaviors but not the mechanisms of learning); *see also* L. Mark Carrier, *Multitasking Across Generations: Multitasking Choices and Difficulty Ratings in Three Generations of Americans,* 25 COMPUTERS HUM. BEHAV. 483, 488 (2009) (finding that basic limitations on multitasking abilities are fairly uniform across generations suggesting that technology has not led to differences in the brains of so-called "digital natives" compared to "digital immigrants"); Pinker, *Mind Over Mass Media*, *supra* note 5 (stating that neural plasticity does not mean the brain can be pounded into shape by experience); Daniel Willingham, *Don't Blame the Internet: We Can Still Think and Read Critically, We Just Don't Want to,* REALCLEAREDUCATION (Apr. 14, 2014), http://www.realcleareducation.com/articles/2014/04/16/dont_blame_the_web_we_can_still_think_and_read_critically_we_just_dont_want_to_942.html [http://perma.cc/MV22-UQUE] [hereinafter Willingham, *Don't Blame the Internet*] (stating that neural plasticity is highly constrained and probably not even capable of changing the brain in response to environmental influences like technology as some lay observers have claimed).

151 *See* DEHAENE, *supra* note 7, at 146 (stating that evolution over millions of years has imposed "severe" limits on what we are able to learn); LEVITIN, *supra* note 113, at 96–98 (claiming that there is no such thing as multitasking); Willingham, *Don't Blame the Internet*, *supra* note 150.

have alarmingly claimed.[152] Increased distractibility may be an occupational hazard of technology use, but it is a learned behavior, that can be unlearned as well, rather than a permanent change in brain structure.[153] To paraphrase Harvard cognitive scientist Professor Steven Pinker, if you want to be less distracted, stop getting distracted.[154] If our students appear distracted in class because of wireless devices, the solution is not to enable that behavior further but to take steps to help them build better attentional abilities.

The assertion that technology has changed the way our students think and learn first appeared in a 2001 essay by Marc Prensky, an educational consultant at the time.[155] It is the same five-page essay in which he coined the phrase "digital native," sending legal educators into a tizzy ever since.[156] Author Nicholas

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152 *See* DEHAENE, *supra* note 7, at 146; Thompson, *supra* note 54, at 13 (stating that while the popular press relies heavily on neural plasticity to support claims that the brain is changing, researchers urge more caution; neural plasticity is involved in all learning and, thus, designed to change only within narrowly constrained limits); Willingham, *Smartphones Are Not Making Us Dumb*, *supra* note 9. *But see* Prensky, *supra* note 1, at 1 (one of the leading alarmists).

Cognitive science tells us that a child's brain is by design more plastic than an adult's to facilitate all the learning that occurs as we grow. *See* MEDINA, *supra* note 67, at 58–59. Those claiming that technology is transforming the brains of digital natives have seized on this to argue that children raised in a technology rich environment develop brains that are "fundamentally" different than those of digital immigrants. *See infra* note 155. Among the many problems with this theory, however, is that it assumes a relatively homogenous population of students raised under similar circumstances with respect to their exposure and use of technology that are distinct from the circumstances under which digital immigrants live. But phenomenologists argue that all man-made creations, including digital ones, are assimilated into the environment we all share—indeed they *become* the environment—meaning their influence has equal effect on all. *See generally* N. KATHERINE HAYLES, HOW WE THINK: DIGITAL MEDIA AND CONTEMPORARY TECHNOGENESIS 10–11 (2012). Consequently, the claim that digital technology is causing a generational divide due to neural plasticity has serious conceptual flaws beyond the lack of empirical support. *See supra* notes 4, 5, 150; *infra* pp. 267–69 and accompanying notes.

153 The ability to pay attention, like most human traits, varies among individuals which means some people are born more easily distracted than others. GALLAGHER, *supra* note 76, at 147–48; *see supra* note 135.

154 *See* Pinker, *Mind Over Mass Media*, *supra* note 5 (asserting that with Internet distractions, you are what you eat; the solution is not to bemoan technology but to develop better strategies for self control); Willingham, *Smartphones Are Not Making Us Dumb*, *supra* note 9 (claiming that there is no evidence the Internet is causing attention spans to shorten); *cf.* GALLAGHER, *supra* note 76, at 10–11 (stating that we can increase our attentional abilities through practice and discipline).

155 Prensky, *supra* note 1, at 1. In this five-page essay, Mr. Prensky states:

> Our students have changed radically. Today's students are no longer the people our educational system was designed to teach. . . . It is now clear that, as a result of this ubiquitous environment and the sheer volume of their interaction with it, today's students think and process information fundamentally differently from their predecessors.

Id.

156 *Id.* To date, research has failed to find any evidence to support Mr. Prensky's

Carr, among others, made a similar claim in his bestselling book *The Shallows: What the Internet Is Doing to Our Brains*.[157]

Cognitive scientists, however, scoff at this notion, pointing out that of course the brain gets rewired every time we interact with environmental influences like technology.[158] That is exactly how neural plasticity is supposed to work in helping us learn new things.[159] The brain does indeed build new neural pathways to support nearly everything we learn just as when we stop doing those things, the pathways decay.[160] But it does not mean neural plasticity can alter the brain's fundamental thinking and learning characteristics.[161] As proof, some point to studies showing that the heaviest multitaskers do worse on tests that measure multitasking proficiency compared to those who do it less.[162] If the Internet was really changing our students' brains, you would expect the heaviest multitaskers to show improvement, not the opposite.[163]

And despite some impressive characteristics, neural plasticity, like working memory, is "severely" constrained by our genetic programming with respect to how and what we are

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assertions that: 1) the Internet is changing the brains of students; or 2) that "digital natives" have unique characteristics that set them apart from so-called "digital immigrants." *See supra* notes 4–5. It is worth noting that in 2001, when Prensky was proclaiming that the Internet is changing students' brains, Yale Professor Jerome Singer, an expert in child psychology, was telling author Dan Oppenheimer that he could not say one way or the other because no serious research had yet been done on the issue. OPPENHEIMER, *supra* note 19, at 201.

157 *See* CARR, *supra* note 139, at 116.

158 *See* Pinker, *Mind Over Mass Media*, supra note 5; Pinker, *Not at All*, *supra* note 9, at 86; Willingham, *Don't Blame the Internet*, *supra* note 150.

159 *See* MEDINA, *supra* note 67, at 57, 62 (asserting that all learning involves changes in the brain; even acquiring a simple piece of information results in the physical alteration of neuronal structures); Pinker, *Mind Over Mass Media, supra* note 5.

160 *See* SYLWESTER, *supra* note 49, at 20, 126.

161 *See* Pinker, *Mind Over Mass Media, supra* note 5; Pinker, *Not at All, supra* note 9, at 87 (claiming that it is "ludicrous" to believe the Internet has changed the way scientists think compared to a decade ago); Willingham, *Smartphones Don't Make Us Dumb*, *supra* note 9; *supra* note 4.

162 Pinker, *Not at All*, *supra* note 9, at 86 (the Ophir & Nass study, *supra* note 113, confirms skepticism about claims that the Internet is changing the brain); *see also* Joshua Greene, *The Dumb Butler*, *in* IS THE INTERNET CHANGING THE WAY YOU THINK?, *supra* note 3, at 133–34 (stating that researchers have documented the so-called "Flynn Effect," showing that average IQs have increased during the twentieth century; if the Internet was changing our brains as some claim, you would expect science would be able to document that too, yet so far there is no evidence to support it); Carrier, *supra* note 150, at 488; *supra* note 4.

163 Pinker, *Not at All*, *supra* note 9, at 87; *see* Carrier, *supra* note 150, at 488; Pagel, *supra* note 9, at 70 (professor of evolutionary biology says we know the Internet has not changed the brain because we can visit people who do not have Internet access and they think the same as we do).

capable of learning.[164] Known as the theory of "innate intelligence," experts say that the brain comes factory-equipped with preinstalled templates for interpreting the world in tightly circumscribed, uniform ways across several key knowledge domains including intuitive physics (e.g., a basic understanding of cause and effect), logical reasoning (e.g., an ability to draw inferences), intuitive psychology (e.g., recognizing others have motives and intentions), and rudimentary mathematics, among other areas, that comprise the fundamental assumptions we all share about how the world works.[165] In the absence of these constraints, from the moment of birth forward, learning for each of us would consist of an "unguided cognitive fumbling" through life.[166]

Neural plasticity is probably too tightly constrained by our genetic engineering for technology to have much, if any, effect on it.[167] In short, technology is not changing the brain in any significant way as some educational consultants and lay commentators claim; rather technology is changing to become more compatible with the way the brain works.[168] Neither are we

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164 *See* DEHAENE, *supra* note 7, at 146 (how the brain thinks and works is "highly circumscribed"); Donald Hoffman, *The Sculpting of Human Thought*, *in* IS THE INTERNET CHANGING THE WAY YOU THINK?, *supra* note 3, at 90–91 (asserting that evolution has placed endogenous limits on learning and although the Internet can change what we learn within those limits, it *cannot* change the limits themselves); Willingham, *Don't Blame the Internet, supra* note 150 (stating that the truth is that the brain is probably not even capable of the changes some have suggested technology is causing).

165 *See* DAVIS, *supra* note 9, at 60–61 (we are born with hardwired intuitions that give children a "head start" when it comes to understanding and learning about the world); PINKER, HOW THE MIND WORKS, *supra* note 10, at 299–362; PLOTKIN, *supra* note 142, 138–51, 171.

The theory of innate knowledge is not without its critics. *See* JERRY FODOR, THE MIND DOESN'T WORK THAT WAY: THE SCOPE & LIMITS OF COMPUTATIONAL PSYCHOLOGY 3 (2001) ("computational nativism" is clearly the best theory of the cognitive mind anyone has thought of so far and it may in fact get the story more or less right, but it is also quite possibly incorrect).

166 PLOTKIN, *supra* note 142, at 171; *see* DAVIS, *supra* note 9, at 38–39 (stating that the architecture of the human brain sets limits on the beliefs we generate and share; in the absence of that, the common culture we share could not exist).

167 *See* KAHNEMAN, *supra* note 71, at 21; PINKER, HOW THE MIND WORKS, *supra* note 10, at 189, 221, 301, 323–30; DEHAENE, *supra* note 7, at 146; Christakis, *supra* note 5, at 202 (even the printing press did not change the way we think); Keith Devlin, *Wisdom of the Crowd*, *in* IS THE INTERNET CHANGING THE WAY YOU THINK?, *supra* note 3, at 280, 282 (executive director of Stanford's H-STAR Institute says the Ophir & Nass study, *supra* note 113, suggests there are endogenous limits to whether digital technology can even change our thinking); Greene, *supra* note 162, at 133 ("The Internet hasn't changed the way we think any more than the microwave oven has changed the way we digest food."); Hoffman, *supra* note 164, at 91. *But see supra* note 9.

168 Scott Atran, *The Fourth Phase of Homo Sapien*, *in* IS THE INTERNET CHANGING THE WAY YOU THINK?, *supra* note 3, at 152, 156. As neuroscientist Maryanne Wolf points out, no matter how revolutionary digital technology might seem to us now, it cannot hold a candle to the effect writing has had on human culture, and even that technology did not

becoming more visually-oriented because of digital technologies.[169] Instead, we are making these devices today because we finally have the technical know-how to give a visually-oriented brain the kind of gadgets it has always wanted right from the start.[170] But as discussed in Part III, that does not mean visual technologies are the best tools for encouraging the kind of deep, effortful engagement needed to impart good critical thinking skills.

C. They Need Face-Time not Facebook

Another important characteristic of the caveman brain relevant to the law school classroom is that it was built for social interaction. This too has origins in our evolutionary past, as natural selection favored social creatures because it conferred significant survival advantages when it came to hunting, foraging, finding a mate, and defending against predators.[171] Early group living also necessitated an ability to figure out what the other guy was thinking, because failing to do so might mean he survived but not you.[172] These early group living arrangements, therefore, contributed to a cognitive arms race that gave the caveman an ability to determine the intentions and motives of others based on subtle facial cues and body language.[173]

This ability to read minds based on limited information also explains the survival imperative served by the "fast and frugal" intuitive thinking described in Professor Daniel Kahneman's

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change the brain or the way we think. WOLF, *supra* note 5, at 66; *accord* DEHAENE, *supra* note 7, at 146, 150 (new inventions can only be acquired insofar as they fit the constraints of our brain's architecture; thus technologies like writing have evolved to fit how the brain works, not vice versa); *cf.* HAYLES, *supra* note 152, at 10 (discussing a phenomenological theory called technogenesis that posits technology and humans co-evolve with each informing the evolution of the other).

169 *See* PINKER, HOW THE MIND WORKS, *supra* note 10, at 206–07 (asserting that the need to adapt to environmental changes does not drive evolution; we do not grow new abilities, rather our abilities find new ways to cope); DEHAENE, *supra* note 7, at 304 (claiming that our cultural inventions are all constrained by our neuronal architecture); Willingham, *Don't Blame the Internet, supra* note 150.

170 *See infra* pp. 275–76 and accompanying notes.

171 *See* PINKER, HOW THE MIND WORKS, *supra* note 10, at 191–92; RATEY, *supra* note 76, at 302–04 (claiming that the brain is much better suited to solving social problems than abstract math problems); SHELL ET AL., *supra* note 68, at 68.

172 *See* PINKER, HOW THE MIND WORKS, *supra* note 10, at 192–93; Laurie R. Santos et al., *The Evolution of Human Mindreading: How Nonhuman Primates Can Inform Social Cognitive Neuroscience*, *in* EVOLUTIONARY COGNITIVE NEUROSCIENCE, *supra* note 122, at 433, 433.

173 *See* KAHNEMAN, *supra* note 71, at 90; MEDINA, *supra* note 67, at 45; PINKER, HOW THE MIND WORKS, *supra* note 10, at 192–93, 329–33.

bestselling book, *Thinking Fast and Slow*.[174] The caveman did not have the luxury of navel gazing or reflectively sifting through all the evidence before deciding how best to respond to threats or opportunities.[175] Rather, he needed to decide "right now!" whether the other guy posed a threat, suss out the worthiness of a potential mate, or identify cheaters in the group who threatened the social contract.[176] Professor Kahneman refers to this type of quick, intuitive thinking as "System 1."[177] Because it relies on partial information and subconscious heuristics, System 1 thinking often contains mistaken assumptions and biases that a more careful assessment of the facts would lay bare.[178]

Professor Kahneman refers to the deliberate, analytical thinking we teach in law school as "System 2."[179] Unlike intuitive System 1, System 2 thinking is innately difficult and effortful.[180] But the caveman brain is lazy—indeed the very purpose of System 1 is to *save* us from having to think at all—so it would

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174 KAHNEMAN, *supra* note 71, at 90–91 (Professor Kahneman is a Nobel Prize winning cognitive scientist).

175 *See* DAVIS, *supra* note 9, at 57 (claiming that had our ancestors been required to spend their full intellectual resources on every problem they faced, it would have been a recipe for disaster); KAHNEMAN, *supra* note 71, at 35; SYLWESTER, *supra* note 49, at 71, 73; WILLINGHAM, WHY DON'T STUDENTS LIKE SCHOOL, *supra* note 48, at 3–4.

176 *See* KAHNEMAN, *supra* note 71, at 90, 243; PINKER, HOW THE MIND WORKS, *supra* note 10, at 403, 415; Cosmides & Tooby, *supra* note 144, at 184; Mark Schaller, *Evolutionary Bases of First Impressions*, *in* FIRST IMPRESSIONS 1, 3 (Nalini Ambady et al. eds., 2008) (claiming that for survival purposes, you were better off falsely assuming the worst about the other guy than incorrectly assuming the best about him).

177 KAHNEMAN, *supra* note 71, at 24.

178 *Id.* at 24, 86, 105 (stating that "System 1" generates impressions, intuitions, and "feelings," which "System 2" often endorses out of sheer laziness, which is what transforms intuition into "belief"); *see* DAVIS, *supra* note 9, at 58 (claiming that heuristic thinking can often result in humans ignoring most of the information available to them); PINKER, HOW THE MIND WORKS, *supra* note 10, at 312–13, 344 (asserting that our brain likes to put things into boxes and organize the world according to stereotypes which are not always accurate).

System 1 is so deeply influential in the way we think because it draws on accumulated experiences and emotions. Indeed, it can be so compelling that it overrides rational thought even among those people who are trained to be dispassionate and analytical. In the book *Make It Stick: The Science of Successful Learning*, the authors discuss just such an example involving commercial airline pilots who relied on System 1 emotionally-driven intuitive thinking rather than trust the aircraft's instruments as their training and reason would dictate, resulting in tragic consequences. PETER C. BROWN ET AL., MAKE IT STICK: THE SCIENCE OF SUCCESSFUL LEARNING 106–08 (2014). The point being that it can be very difficult for a teacher to get students to engage System 2 logical reasoning rather than defaulting to System 1's emotionally-driven intuition. *Id.*

179 *See* KAHNEMAN, *supra* note 71, at 31.

180 *See id.* at 31, 35, 45–46, 81, 99, 103 (System 1 is characterized by intellectual sloth while System 2 is the skeptic); PINKER, HOW THE MIND WORKS, *supra* note 10, at 344–45 (because of the existence of System 1 thinking, watching college students work on logic problems is not a pretty sight); WILLINGHAM, WHY DON'T STUDENTS LIKE SCHOOL, *supra* note 48, at 4.

much rather avoid the heavy-lifting that System 2 requires.[181] What this means for law professors is that we will be most effective when challenging students in ways that show them their intuitive, "common sense" solutions to the problems we pose will not work. Professor Kahneman tells us that, generally speaking, it is only after System 1 breaks down that System 2 takes over, applying logic and reason to work on the problem at hand until it finds a solution.[182]

The foregoing might lead one to wonder that if the caveman brain is designed for System 1, fast-and-frugal solutions to the problems associated with living as part of a nomadic, foraging tribe of socialites, why would evolution also give it the intellectual firepower of System 2 which we use today to solve calculus problems, send a man into space, and invent online shopping.[183] The caveman, after all, did not need to do any of those things to survive. If evolution is such an efficient mistress, what purpose did System 2 serve?[184]

The premise of evolutionary psychology is that the cognitive abilities we use today to solve the problems of modern life have all been repurposed from the ones our ancestors used to survive on the African savannah.[185] Though our brain was never designed for the critical thinking skills we teach in law school, students are still able to do it, with great effort and difficulty,

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181 *See* DAVIS, *supra* note 9, at 57–58 (heuristics are a form of intellectual laziness); KAHNEMAN, *supra* note 71, at 24, 31, 99 (laziness is built deep into our nature; the brain would rather endorse intuitive solutions generated by System 1 than do the hard work required to make a critical assessment under System 2); PINKER, HOW THE MIND WORKS, *supra* note 10, at 307–09 (the brain did not evolve to be a good scientist; it did not evolve for "truth"—it evolved to put things into categories and draw inferences from them); WILLINGHAM, WHY DON'T STUDENTS LIKE SCHOOL, *supra* note 48, at 3 (the brain is designed to *save* us from thinking).

Some cognitive scientists theorize that multitasking and other distracting behaviors are a form of procrastination to help us avoid System 2 thinking. *See* Glenn, *supra* note 109. This, of course, is another, independent reason to ban wireless devices from the law school classroom in particular.

182 KAHNEMAN, *supra* note 71, at 24–25, 45–46; *see* CAREY, *supra* note 7, at 3 (learning is deeper and better when it is effortful); WILLINGHAM, WHY DON'T STUDENTS LIKE SCHOOL, *supra* note 48, at 132 (intelligence is shaped by hard work).

183 *See* PINKER, HOW THE MIND WORKS, *supra* note 10, at 352.

184 *See id.*; *supra* p. 21 and note 120.

185 *See* DAVIS, *supra* note 9, at 13; DEHAENE, *supra* note 7, at 147; PINKER, HOW THE MIND WORKS, *supra* note 10, at 23, 42; RATEY, *supra* note 76, at 304. The premise of evolutionary psychology—that the brain evolved in response to environmental pressures just like every organism—is, generally speaking, as well accepted as traditional Darwinian evolutionary theory. Nonetheless, some of the particular explanations offered for specific psychological traits, such as why girls prefer the color pink, have been the subject of criticism. *See* Bolhuis et al., *supra* note 9 (summarizing criticism of some aspects of evolutionary psychology).

because, as evolutionary psychologists tell us, being a caveman back in the day took a lot more smarts than first meets the eye.[186]

Life back then was like being on a camping trip that lasted the rest of your life, but without the tent, Swiss Army knife, fishhook, space blanket, or freeze-dried linguine.[187] To be a successful hunter, you had to out-think your prey to anticipate its next move.[188] You also needed the analytical acumen to read the minds of others based on split-second social cues.[189] And don't forget those vexing climate change issues we still haven't figured out. It goes to show that the only difference between knowing whether your fellow caveman wants to "friend" you or beat you to a pulp and solving the problem of sustainable nuclear fusion is just a matter of degree.

The implications for legal educators are at least two-fold. First, it tells us the brain is not very good at "thinking like a lawyer."[190] While students rise to the occasion, the law school curriculum will always remain innately difficult and effortful.[191] Hope springs eternal that technology can save students, and us, from some of the drudgery, though history reminds us that fools rush in where angels fear to tread.[192] Adopting new technologies we do not fully understand in an "unrelenting search," in the words of Professor Cuban, for learning efficiencies that may not even exist, can easily make things worse by reinforcing lazy caveman intuitive thinking instead of promoting effortful System 2.[193]

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186 *See* DAVIS, *supra* note 9, at 44–45 (the ability to peer into the mind of another based on characteristics not physically obvious takes great intellectual prowess); PINKER, HOW THE MIND WORKS, *supra* note 10, at 301 (prospering as a forager back in caveman days required more smarts than being a good chess player today).

187 *See* PINKER, HOW THE MIND WORKS, *supra* note 10, at 188, 375; Cosmides & Tooby, *supra* note 144, at 185.

188 *See* CAREY, *supra* note 7, at 214–15; PINKER, HOW THE MIND WORKS, *supra* note 10, at 195.

189 *See* Schaller, *supra* note 176, at 2–3; *see also* SYLWESTER, *supra* note 49, at 53–54 (the brain evolved to make quick, intuitive, stereotyped decisions, not accurate ones); *see supra* p. 270 and notes 175–176.

190 *See* CAREY, *supra* note 7, at 82 ("school" learning feels difficult because it is); PINKER, HOW THE MIND WORKS, *supra* note 10, at 42, 340–42, 358–59 (our minds were adapted for the Stone Age, not the Computer Age); SHELL ET AL., *supra* note 68, at 66–67, 122; WILLINGHAM, WHY DON'T STUDENTS LIKE SCHOOL, *supra* note 48, at 3–5.

191 *See* DEHAENE, *supra* note 7, at 303 (the brain never evolved to do schoolwork like reading); STEVEN PINKER, THE BLANK SLATE 223, 342 (2002) (much of formal education is cognitively unnatural and mastering it is not easy despite the mantra that "learning is fun"); SHELL ET AL., *supra* note 68, at 15, 66–67, 122.

192 *See supra* Part I.

193 *See* CUBAN, TEACHERS AND MACHINES, *supra* note 16, at 73 (Professor Cuban describes educators as being in an "unrelenting" pursuit of teaching efficiencies through technology).

Second, with so much focus on technology, it is easy to overlook that the most effective classroom tool we have is the ancient caveman mind-meld technique that enables us to tell at a glance whether students are "getting it" or not so we can make appropriate adjustments.[194] The brain is a far more sophisticated computer than the love-child of IBM's Watson and Sergey Brin could ever hope to be.[195] And while many teachers may be unaware of the evolutionary underpinnings, it is why we have always placed great importance on good classroom rapport.[196] The concern that putting "machines" in the classroom may interfere with that is a legitimate one, which we must continue to zealously protect.[197] It is the reason MOOCs are "lousy" and why the social media "revolution" that promised to make us more connected is instead making us isolated and lonely.[198] The brain is designed for real interaction, not the virtual kind.[199] Technology offers incredible learning opportunities, but student success will always depend first and foremost on the human touch, which means what they need from us most is face-time, not Facebook.[200]

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194 *See* DAVIS, *supra* note 9, at 67–68 (the ability to read students' minds to tell whether they are confused, or engaged, may be the single most important asset of a good teacher and doing it well likely predicts the good ones from the bad).

195 Watson is an IBM supercomputer that went on TV to beat champion contestants on the game show Jeopardy and is now being programmed to do legal research and other legal practice tasks. *See* John Markoff, *Computer Wins on 'Jeopardy!': Trivial, It's Not,* N.Y. TIMES, at A1 (Feb. 17, 2011), http://www.nytimes.com/2011/02/17/science/17jeopardy-watson.html?emc=eta1&_r=0 [http://perma.cc/7XLN-C5BN]; Adriana Krasniansky, *Meet Ross, the IBM Watson-Powered Lawyer*, PSFK (Jan. 29, 2015), http://www.psfk.com/2015/01/ross-ibm-watson-powered-lawyer-legal-research.html [http://perma.cc/7XLN-C5BN] (University of Toronto created legal research app for Watson).

196 *See* MEDINA, *supra* note 67, at 45 (there is plenty of empirical support for the proposition that the quality of an education depends on the relationship between the teacher and students); EVGENY MOROZOV, TO SAVE EVERYTHING, CLICK HERE 9 (2013) (President of Williams College says research shows the best predictor of student intellectual success is the amount of face-to-face contact with professors); SYLWESTER, *supra* note 49, at 128.

197 *See supra* p. 253, note 60.

198 *See* LEVITIN, *supra* note 113, at 127, 130–31 (social media is not an adequate replacement for real interaction); SHERRY TURKLE, ALONE TOGETHER: WHY WE EXPECT MORE FROM TECHNOLOGY AND LESS FROM EACH OTHER *passim* (2012); Robert P. Provine, *Internet Society*, *in* IS THE INTERNET CHANGING THE WAY YOU THINK?, *supra* note 3, at 168, 168 (psychologist-neuroscientist says that face-to-face contact is the "gold standard" of interpersonal communication); *supra* p. 248 and notes 26–27; *supra* p. 253 and note 60.

199 *See* PINKER, HOW THE MIND WORKS, *supra* note 10, at 416; Provine, *supra* note 198, at 168; SYLWESTER, *supra* note 49, at 128.

200 *See* MEDINA, *supra* note 67, at 45 (the ability to learn has deep roots in relationships); MOROZOV, *supra* note 196, at 9; OPPENHEIMER, *supra* note 19, at 397 (education depends on meaningful contact between a good teacher and an inquiring student).

D. The Eyes Have It: The Reality and Myths of Visual Learning

A pervasive assumption about "digital natives" is that they are mostly visual learners who do best with screen-based technologies. The assumption is grounded in "learning style" theory, which posits that every student has a unique way of learning based on one of the main senses like sight or hearing.[201] Thus, a "visual learner" should learn best when the teacher uses visual modalities like PowerPoint, while an "auditory learner" learns best listening to a verbal explanation. [202]

The theory is easy enough to prove by showing that visual learners test better after looking at a pictorial explanation of the material versus a lecture and vice versa for auditory learners.[203] Though several studies have looked for evidence to support learning style theory, none has been found.[204] Professor Daniel Willingham, an expert on cognitive science and learning, points out that common sense tells us that even a student claiming to be an auditory learner will not, for example, learn geography better by listening to a description of the countries' shapes rather than looking at a map.[205] Neither will a visual learner learn a foreign language by studying the alphabet instead of listening to a pronunciation of the words.[206] The best way to teach and learn any subject is to employ the methods that are most compatible with the desired outcome.[207] Using visual technologies in the mistaken belief that "digital natives" learn best this way will have negative consequences if, because of that mistaken assumption, we overlook another modality that is better suited to the objective.[208]

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201 *See* WILLINGHAM, WHY DON'T STUDENTS LIKE SCHOOL, *supra* note 48, at 113, 120; Harold Pashler et al., *Learning Styles: Concepts and Evidence,* 9 PSYCHOL. SCI. PUB. INT. 105, 116–17 (Dec. 2008) (meta-analysis of independent learning style studies found no evidence to support it); Daniel Willingham, *Classroom Practice—Listen Closely, Learning Styles Are a Lost Cause,* TES (Feb. 13, 2015), https://www.tes.co.uk/article.aspx?storycode=6451360 [http://perma.cc/Z9SS-YB3J] [hereinafter Willingham, *Learning Styles Are a Lost Cause*] (science has proven learning styles do not exist).

202 Willingham, *Learning Styles Are a Lost Cause*, *supra* note 201.

203 *See* WILLINGHAM, WHY DON'T STUDENTS LIKE SCHOOL, *supra* note 48, at 120; Willingham, *Learning Styles Are a Lost Cause*, *supra* note 201.

204 *See* SHELL ET AL., *supra* note 68, at 101; WILLINGHAM, WHY DON'T STUDENTS LIKE SCHOOL, *supra* note 48, at 120–21; Pashler, *supra* note 201, at 116–17; Willingham, *Learning Styles Are a Lost Cause*, *supra* note 201.

205 *See* WILLINGHAM, WHY DON'T STUDENTS LIKE SCHOOL, *supra* note 48, at 120.

206 *Id.*; Willingham, *Learning Styles Are a Lost Cause*, *supra* note 201.

207 *See* BROWN ET AL., *supra* note 178, at 131–32 (learning style theory is part of teaching folklore, but even if everyone has a learning preference, it does *not* mean students will learn better when the teacher's instructional method fits that preference).

208 *See* BROWN ET AL., *supra* note 178, at 145–46 (because no evidence supports learning style theory, teachers should focus on trying to match the instructional methods with their classroom goals because at least that strategy has a basis in empiricism).

But even if learning styles existed, learning science makes it abundantly clear that digital natives are no more visually-oriented than anyone else. That is because the entire species evolved to be highly visual, not just the recent few who grew up looking at screens.[209] Vision is by far the brain's most dominant sense, though haptics gives it a run for its money.[210] Vision takes up more neurological real estate than all the other senses combined.[211] The eyes are also the only sensory organs that do not do double duty like the ears or nose; their sole purpose is to transmit visual data to the brain.

Evolutionary theory tells us that vision is so dominant because there is a strong correlation between it and survival.[212] Simply put, you cannot find food and avoid predators if you cannot see them. Among the advantages, a good set of peepers made the caveman a more successful hunter and gatherer.[213] Because natural selection also gave him the deluxe color edition, a rarity in the animal kingdom, he ate better than his fellow forest critters since he could tell which fruits were ripe based on their bright colors.[214] But wait, there's more!—because the caveman also got the rare stereoscopic package which enabled him to move better in the forest and grab food with his hands.[215]

Having 3-D vision also meant the caveman could see objects positioned in space in relation to each other.[216] Because of this, evolutionary psychologists theorize that stereoscopic vision contributed to the development of our analytical mind.[217] The theory goes that because all analytical thinking is based on comparisons, the caveman's ability to perceive objects in relation to each other is the reason the legal analysis we teach in law school today is based on comparing the facts of one case to another.[218] If not for 3-D vision, who knows what "thinking like a lawyer" might mean instead!

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209 *See* PINKER, HOW THE MIND WORKS, *supra* note 10, at 214 (we are highly visual creatures because our mind actually evolved around that sense).

210 *See id.* at 191; SYLWESTER, *supra* note 49, at 61; *infra* Section III.D–E.

211 *See* MEDINA, *supra* note 67, at 231–32 (about half of the brain's resources are devoted to vision; it is the "dictatorial emperor"); SYLWESTER, *supra* note 49, at 61.

212 *See* PINKER, HOW THE MIND WORKS, *supra* note 10, at 191.

213 *See id.*

214 *Id.*

215 *See id.* at 191–94. Because of this, a "profound and intimate" connection evolved in the brain between the eye and hand that has many important implications for teachers. *See infra* p. 276 and notes 224–25; *infra* p. 300 and note 355; *infra* p. 301 and note 359 (this ancient connection enables the brain to unify and coordinate the eye, hand, and attention all in one place, at one time).

216 *See* PINKER, HOW THE MIND WORKS, *supra* note 10, at 191.

217 *Id.* at 191–92.

218 *See id.* at 191.

Linguists posit that vision also played a key role in the development of language.[219] According to this theory, the oldest form of communication was purely visual, based on a vocabulary of physical gestures that later became the grunts and groans of a proto-language before morphing into modern, spoken language.[220] Thus, the caveman, not digital natives, was the "OG" visual learner, relying on observation and imitation for all communication.[221] Spoken language only came along much later, replacing the caveman pantomime routine, which had no doubt grown tiresome by then.[222] Of course, that's when things got really interesting, because words allowed our forebears to communicate in abstract ideas. The rest, as they say, is history.

Some experts believe an ancient connection still exists between brain circuits devoted to language and physical movement.[223] They argue it helps explain the research discussed in Section III.D–E that tangible media like books, which students must physically manipulate to use, can enhance learning compared to their electronic counterparts. It is also consistent with the theory of embodied cognition, which says that because the mind and body evolved together, with each heavily informing the design and function of the other, a profound connection still exists between them in all cognitive activity.[224] In effect, we think with our mind *and* body.[225]

III. Strategies for Using Classroom Technologies Even a Caveman Would Love

Based on the foregoing, this Part offers strategies informed by both history and learning science for using several popular classroom tools in ways that promote the skills needed to "think like a lawyer." This includes suggestions for making better use of laptops, visual tools like PowerPoint, reading technologies, and

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219 *See* Richerson & Boyd, *supra* note 82, at 144; *infra* p. 296 and notes 331–32.

220 *See* Richerson & Boyd, *supra* note 82, at 144 (people might have been mute until relatively recent times); Michael C. Corbalis, *The Evolution of Language: From Hand to Mouth, in* Evolutionary Cognitive Neuroscience *supra* note 122, at 403, 413.

221 *See* Richerson & Boyd, *supra* note 82, at 136, 144.

222 *See* Corbalis, *supra* note 220, at 413.

223 *See infra* p. 296 and notes 331–32.

224 *See* Pinker, How the Mind Works, *supra* note 10, at 194; Ratey, *supra* note 76, at 178; Sylwester, *supra* note 49, at 57 (our skin is where the brain meets the outside world); Frank R. Wilson, The Hand: How Its Use Shapes the Brain, Language And Culture 286, 289 (1998) (the clear message from biology to educators is that the most effective teaching techniques aim at uniting, not divorcing, mind and body); Brandon Keim, *The Science of Handwriting*, 24 Sci. Am. Mind 54, 56 (Sept./Oct. 2014), http://www.scientificamerican.com/article/the-science-of-handwriting/ (the mind-body connection is paramount; we use our hands to access our thoughts).

225 *See infra* p. 278 and note 234; pp. 296–97 and notes 326–33.

writing technologies.[226] Also included is a summary of two of the largest meta-studies to date that analyzed the overall effectiveness of classroom digital teaching technologies based on a review of thousands of independent studies. Before getting to the specifics of each of these discussions, however, the following are some general guidelines to consider whenever contemplating the use of a new classroom technology based on a synthesis of the many studies cited in this section.[227]

A. General Guidelines

Experience tells us that the best place to start whenever considering the use of a new classroom technology is to identify a good reason for using it and then ask whether it serves that purpose better than the alternatives.[228] Forget learning styles—this is about trying to create a good match between the classroom tools available to us and our learning objectives.[229] Experience also tells us that new technologies work best when used to fill a pedagogical niche not addressed by existing options.[230] Conversely, they have a history of failing when the teacher

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226 *See* Palfrey, *supra* note 7, at 109 (best practices for technology use in law school means knowing when *not* to use it).

227 This Article addresses only the use of classroom technology as a pedagogical tool, not the question of whether we should be teaching students the substantive technology skills they will need as lawyers. In this author's view, whenever the opportunity arises to use classroom technology in ways that also demonstrate legal practice skills, we should take it, as the importance of technological proficiency to the practice of law cannot be overstated. *See* Canick, *supra* note 35, at 681–85; Stephen M. Johnson, *Teaching for Tomorrow: Utilizing Technology to Implement the Reforms of MacCrate, Carnegie and Best Practices*, 92 NEB. L. REV. 46, 82–85 (2013); GENE KOO, NEW SKILLS, NEW LEARNING: LEGAL EDUCATION AND THE PROMISE OF TECHNOLOGY 12–15, 18–22 (The Berkman Ctr. for Internet & Soc'y at Harvard Law Sch., Research Publication No. 2007-4, March 2007), https://cyber.law.harvard.edu/publications/2007/New_Skills_New_Learning. However, the assumption made by this Article is that most technology, especially in first-year courses, is not used in that way, but instead as a teaching tool based on the belief that "digital natives" have a unique learning style which this Article challenges.

It should also be noted that while many of the studies discussed in this Part involved university students, I did not find any that focused solely on law students. This may matter only insofar as a reason exists why the results of these studies cannot be generalized to a law student population.

228 *See* STEVEN HIGGINS ET AL., THE IMPACT OF DIGITAL TECHNOLOGY ON LEARNING: A SUMMARY FOR THE EDUCATION ENDOWMENT FOUNDATION 4, 8 (2012) [hereinafter DURHAM STUDY]; PALFREY & GASSER, *supra* note 23, at 246 (the most successful strategy for using classroom technology is to first identify the pedagogical goal and then ask whether the technology in question can help; often times this means *not* using it); Palfrey, *supra* note 7, at 115 ("best practices" for law school means only using technology when it serves a specific pedagogical purpose); *supra* p. 253 and note 57.

229 *See* PALFREY & GASSER, *supra* note 23, at 246 (in legal education, one of the best ways to teach students critical thinking skills involves no technology at all but "old fashioned dialogue" between teacher and student).

230 *See* DURHAM STUDY, *supra* note 228, at 4, 8; Cuban, *Online Instruction-3*, *supra* note 39 (new classroom technology always finds a niche smaller than originally promised).

merely substitutes a new, more novel tool for one that is already serving its purpose well.[231]

Related to this is the "more is better" fallacy of classroom technology; if adding a little is good, than adding more must be even better.[232] For example, visual technologies like film, video, and PowerPoint have become an indispensable part of every teacher's classroom repertoire because they fill a niche that other tools cannot. Yet they have failed to replace textbooks, despite several efforts over the past 100 years, because print is often more compatible with many classroom objectives such as helping students develop critical thinking skills.[233]

As this suggests, the medium matters in assessing how well a particular technology promotes the teacher's learning objectives. Part II tells us that the caveman, like Madonna, was built for a material world, not a virtual one, in which mind and body work together in all cognitive activity.[234] Research on classroom technology is consistent with this insofar as tools that incorporate tactile, or "haptic," characteristics like books, pens, and paper are effective multimodal learning tools that help promote critical thinking by more deeply engaging students both visually and physically.

Teaching students to "think like a lawyer" means that we must also consider whether our classroom tools promote important foundational skills like attention and focus.[235] The relationship between the ability to pay attention and success in school is well established, as is the one between interferences with attention and weaker learning outcomes.[236] Since wireless

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231 *See* DURHAM STUDY, *supra* note 228, at 4, 8; PALFREY & GASSER, *supra* note 23, at 246 (educators make a mistake when they scrap what works in favor of using the newest, coolest tools); *supra* p. 253 and notes 56–58.

232 *See* DURHAM STUDY, *supra* note 228, at 6, 21; *see also* PALFREY & GASSER, *supra* note 23, at 246–47 (there is a tendency to over promote and fetishize the use of technology when it comes to digital natives; that instinct is wrong); *supra* Part I.

233 *See* CUBAN, TEACHERS AND MACHINES, *supra* note 16, at 58 (textbooks have endured because they are flexible); Palfrey, *supra* note 7, at 106 (at Harvard Law School, you'll still see lots of old fashioned bound textbooks being used because they remain an effective technology for conveying information to students); *supra* pp. 247–48 and accompanying notes; *infra* Section III.D.

234 MADONNA, *Material Girl*, *on* IMMACULATE COLLECTION (Sire Records 1984); *see* POWERS, *supra* note 5, at 153–54 (physical tools are actually easier on the mind than electronic ones because they allow the brain to off-load some of the cognitive burden to the body); WILSON, *supra* note 224, at 286, 289; James Minogue & M. Gail Jones, *Haptics in Education: Exploring an Untapped Sensory Modality*, 76 REV. EDUC. RES. 317, 317–19 (2006); *supra* p. 276 and notes 223–25; *infra* p. 296 and accompanying notes.

235 *See* GALLAGHER, *supra* note 76, at 10, 67 (studies increasingly show we can cultivate deep attention through practice and discipline).

236 *See* MEDINA, *supra* note 67, at 74 (research spanning 100 years clearly shows that

devices are the chief source of unwanted disturbances in the classroom, we must continually weigh how well their use promotes our objectives against the distractions they cause. Sometimes this will tip in favor of using these devices, while other times we need to turn them off in favor of an alternative.

A primary rationale for using new technology in the first place has always been the assumption that it helps motivate students to learn. However, one of the largest meta-studies to date on the effectiveness of digital classroom technologies found no evidence to support that widely held belief.[237] Rather, the researchers found that new technology may enhance initial student interest but that does not lead to better learning outcomes unless the teacher is also able to leverage it into more effortful work.[238] This suggests that adopting a new technology solely for the purpose of better motivating students may actually be counterproductive if it is not otherwise well-suited to the particular learning objective.

B. "Should I Stay or Should I Go?": What to Do About Laptops

Law schools began making laptops mandatory and installing wireless connections in the late 1990s as both were becoming increasingly popular outside the classroom.[239] Some administrators saw the opportunity to brand their schools as "early adopters" which conferred instant status as innovators.[240] The decision to install these technologies was also motivated by

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better attentional abilities equals better learning); Megan M. McClelland et al., *Relations Between Preschool Attention Span-Persistence and Age 25 Educational Outcomes*, 28 EARLY CHILD. RES. Q. 314, 315–16 (2012) (attention span is especially relevant to doing well in school and academic attainment); Glenn, *supra* note 109 (strong attentional abilities produce stronger fluid intelligence); *infra* pp. 282–83 and accompanying notes.

237 DURHAM STUDY, *supra* note 228 at 20; *see* Thompson, *supra* note 54, at 20 (the assumption that technology motivates students to learn is often false because they neither love it, use it, nor are as proficient with it as many educators assume); *infra* notes 251, 266 (student surveys show they do not want technology in the classroom unless the teacher is making effective use of it).

238 DURHAM STUDY, *supra* note 228, at 4, 20; *see* Deborah B. McCabe & Matthew L. Meuter, *A Student View of Technology in the Classroom: Does It Enhance the Seven Principles of Good Practice in Undergraduate Education?*, 32 J. MARKETING EDUC. 149, 149, 154 (2011) (study concludes students enjoyed using many of the online tools tested but did not believe they enhanced their learning experience); Thompson, *supra* note 54, at 21 (student survey contradicts popular assumption that they demand constant use of technology in the classroom); Wang, *supra* note 54, at 640 (survey of university students found that technology is sometimes used because of teacher stereotyping rather than student demand).

239 *See* PALFREY & GASSER, *supra* note 23, at 237–38; Caron, *supra* note 56, at 555–56 (during the 1990s the "technology bandwagon" rolled virtually unchecked into law schools across the land).

240 *See* DeGroff, *supra* note 56, at 206; *supra* pp. 250–51 and notes 39–42.

an "academic moral panic" over the supposedly changing learning styles of digital natives.[241] As the unintended consequences of these decisions came to light, it has led to more debate among law professors than any other technology issue in recent memory.[242]

The chief issue is whether students are misusing laptops during class in ways that interfere with their learning and what, if anything, professors should do about it. Some take a laissez-faire approach, believing that law students are adults who should make their own decisions about what they do in class.[243] Others have responded by banning laptops altogether, including, ironically, the co-founder of Harvard's Berkman Center for Internet and Society, Professor Jonathan Zittrain.[244] Still others have invested considerable time and effort trying to figure out what exactly students are doing on their laptops before deciding on a policy.[245] Finally, some have created laptop-free zones in an effort to accommodate each student's preference.[246]

The variety of responses reflects the degree to which professors have earnestly struggled to find a good solution that balances all the interests involved. Nonetheless, each of these strategies has problems. Banning laptops altogether means giving up a great interactive, multimodal learning tool that lets students explore subjects on their own during class. Relying on student opinion to set classroom policy is problematic because at

241 *See supra* p. 243 and note 5; *see also supra* p. 247 and note 18.

242 A quick search in WestlawNext for articles discussing the use of laptops in law school turned up more than 100 results. Among the many, see DeGroff, *supra* note 56, at 206 (citing to several articles discussing these issues).

243 I have no cites to offer because professors who take a laissez-faire approach generally do not write articles extolling the virtues of doing nothing.

244 Tracy Jan, *Tangled in an Endless Web of Distractions*, BOSTON.COM (Apr. 24, 2011), http://www.boston.com/news/local/massachusetts/articles/2011/04/24/colleges_worry_about_always_plugged_in_students/ [http://perma.cc/RLD6-R2K8] (discussing Professor Zittrain's decision to ban laptops); *see* Palfrey, *supra* note 7, at 108 (many Harvard law professors ban classroom laptops); *see also* DeGroff, *supra* note 55, at 207 (noting several top law schools, including the Universities of Chicago, Michigan, Virginia, as well as Vanderbilt, have installed mechanisms that allow professors to disable or block Internet access).

245 *See* Kristen E. Murray, *Let Them Use Laptops: Debunking the Assumptions Underlying the Debate over Laptops in the Classroom*, 36 OKLA. CITY L. REV. 185, 198–201 (2011); Jeff Sovern, *Law Student Laptop Use During Class for Non-class Purposes: Temptation v. Incentives*, 51 U. LOUISVILLE L. REV. 483, 484–86 (2011); *see also* Eric D. Ragan et al., *Unregulated Use of Laptops over Time in Large Lecture Classes*, 78 COMPUTERS & EDUC. 78, 84–85 (2014) (survey found that students who brought laptops to class engaged in off-task activities two-thirds of the time).

246 *See* Jana R. McCreary, *The Laptop-Free Zone*, 43 VAL. U. L. REV. 989, 997 (2009); *see also* Nancy M. Aguilar-Roca, *The Impact of Laptop-Free Zones on Student Performance and Attitudes in Large Lectures*, 59 COMPUTERS & EDUC. 1300, 1306 (2012) (discussing experiment with laptop free zones outside the law school context).

least one study found they dramatically underreport their off-task behavior.[247] Students also overestimate their ability to learn while multitasking, so they might not even see it as a problem worthy of reporting.[248] On the other hand, creating laptop-free zones may not protect non-laptop users from the distractions caused by their neighbors due to the contagion effect.[249] It also fails to shield other laptop users who are trying to stay on task.[250] The laissez-faire approach suffers from the same problems, but good luck convincing that guy to change.

Learning science makes the decision easy. Unless the professor is having students use their laptops as part of an in-class exercise or is otherwise actively managing their use, they should be closed or turned off. This is the only policy that strikes the right balance between the value laptops have as an

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247 J.M. Kraushaar & David Novak, *Examining the Effects of Student Multitasking with Laptops During the Lecture*, 21 J. INFO. SYS. EDUC. 241, 248–50 (2010) (study compared student self-reporting of classroom multitasking to data gathered via spyware which showed they substantially underreported their off-task behavior); *see* Ravizza et al., *supra* note 115, at 112 (university students likely underreport their classroom use of wireless devices for off-task activities). In some surveys, however, students have volunteered that they use their laptops for off-task activities most of the time. *See* Ragan et al., *supra* note 245, at 81, 84–85. *But see* Miri Barak et al., *Wireless Laptops as Means for Promoting Active Learning in Large Lecture Halls,* 38 J. RES. TECH. EDUC. 245, 247–48, 251 (2006) (students enrolled in computer engineering course reported favorable experience using laptops in class for interactive exercises); Robin Kay & Sharon Lauricella, *Unstructured vs. Structured Use of Laptops in Higher Education*, 10 J. INFO. TECH. EDUC. 33, 38 (2011) (based on student self reporting, researchers found off-task use of laptops during class was less than expected).

248 *See* BROWN ET AL., *supra* note 178, at 121 (discussing the "Dunning-Kruger effect," which is the phenomenon that recognizes unskilled students overestimate their abilities); Fang-Yi Flora Wei et al., *An Experimental Study of Online Chatting and Notetaking Techniques on College Students' Cognitive Learning from a Lecture,* 34 COMPUTERS HUM. BEHAV. 148, 149 (2014) (college students do not believe multitasking interferes with learning); Ravizza et al., *supra* note 115, at 113 (and studies cited therein); Glenn, *supra* note 109 (students who multitask labor under the "illusion of competence" that they are performing well); *infra* p. 284 and note 262.

249 *See* Faria Sana et al., *Laptop Multitasking Hinders Classroom Learning for Both Users and Nearby Peers*, 62 COMPUTERS & EDUC. 24, 29 (2012) (students seated in view of multitasking peers had impaired comprehension); Emily Gasper et al., Student Laptop Use in the Classroom and Its Impact on Student Learning (May 6, 2013) (unpublished senior thesis, Ithaca State University) (on file with author) (student authored survey found that university students were disrupted during class due to the laptop contagion effect); Clay Shirky, *Why Clay Shirky Banned Laptops, Tablets and Phones from His Classroom,* MEDIASHIFT (Sept. 15, 2014), http://www.pbs.org/mediashift/2014/09/why-clay-shirky-banned-laptops-tablets-and-phones-from-his-classroom/ [http://perma.cc/6ZXD-87M6]; *see also* Matt Richtel, *Attached to Technology and Paying a Price*, N.Y. TIMES (June 6, 2010) http://www.nytimes.com/2010/06/07/technology/07brain.html?pagewanted=all [http://perma.cc/5MAZ-R6R6] (Professor Shirky refers to this as the "second hand smoke" problem and is another reason why he decided to ban laptops). *But see* Aguilar-Roca, *supra* note 246, at 1306 (study found that students sitting in a no-laptop zone were not disturbed by laptop users though "spreading effect" *did* increase distraction among laptop users).

250 *See* Aguilar-Roca, *supra* note 246, at 1306; Sana et al., *supra* note 249, at 29.

interactive learning tool and our evolutionary programming, which makes it nearly impossible for the caveman brain to resist the distractions they cause.[251] This is especially true given that many wireless devices and websites are designed to distract users with a barrage of instant notifications, pop-ups, and links tailored to each user's personal interests.[252] Due to the contagion effect, it only takes a few students to succumb to the siren call of Facebook or online shopping to cause a distraction that interferes with the learning of many others.[253]

The relationship between the ability to pay attention and success in school is well established, as is the one between distractions caused by wireless devices and negative learning outcomes.[254] One study tried to quantify the effect by finding that college students who multitask during class could expect their

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251 Palfrey, *supra* note 7, at 109 (best practices for classroom technology use in law school means knowing when *not* to use it); *see* PALFREY AND GASSER, *supra* note 23, at 246 (surveys of digital natives show they prefer a moderate amount of technology use in the classroom); Kay & Lauricella, *supra* note 247, at 38 (structured use of laptops during class resulted in significantly more on-task behaviors than unstructured use); Ragan et al., *supra* note 245, at 81 (survey found that many students do not see significant value in bringing laptops to class unless the teacher makes active use of them); Shirky, *supra* note 249.

252 *See* Ragan et al., *supra* note 245, at 78, 85 (study conducted in large introductory college course found students used laptops for off-task activities approximately two-thirds of the time; on-task exploration of subject matter was "rare"); Shirky, *supra* note 249.

253 *See supra* note 249.

254 *See* GALLAGHER, *supra* note 76, at 146, 151–55; Aguilar-Roca, *supra* note 246 at 1304, 1306 (students who multitasked in class had "significantly" fewer A's than non-laptop users, even though the former group's SAT scores predicted they would outperform the non-laptop users); Flora Wei et al., *supra* note 248, at 149, 155 (multitasking during class had negative effect on quality of students' class notes); Carrie B. Fried, *In-Class Laptop Use and Its Effects on Student Learning,* 50 COMPUTER & EDUC. 906, 911 (2008) (finding correlation between in-class laptop use by college students and lower test scores); Reynol Junco & Sheila R. Cotton, *The Relationship Between Multitasking and Academic Performance*, 59 COMPUTERS & EDUC. 505, 512–13 (2012) (frequency of multitasking correlated with drop in college GPA); Lee et al., *supra* note 108, at 96–97 (noting several studies showing a negative correlation between multitasking during class and poor learning outcomes due to the strain it placed on working memory's ability to process information); Ravizza et al., *supra* note 115, at 112–13 (there is a significant association between classroom Internet use and poor test performance, which may have a greater adverse effect on the best students); Sana et al., *supra* note 249, at 30 (multitasking during class impaired complex learning of university students as well as "simple factual learning"); Maryellen Weimer, *Students Think They Can Multitask. Here's Proof They Can't*, FACULTY FOCUS (Sept. 26, 2012), http://www.facultyfocus.com/articles/teaching-professor-blog/multitasking-confronting-students-with-the-facts/ [http://perma.cc/3L89-DPEP] (describing several empirical studies showing negative effect of multitasking on learning); *see* Ophir et al., *supra* note 113, at 15585 (the Ophir & Nass study is widely cited for the proposition that heavy multitaskers test poorly on several cognitive functions related to learning). *But see* Helene Hembrooke & Geri Gay, *The Laptop and the Lecture: The Effects of Multitasking in Learning Environments*, 15 J. COMPUTING HIGHER EDUC. 46, 59 (2003) (while multitasking had negative effect on student memory based on traditional testing, it did not impair their overall class performance).

grades to plummet from a "B" to a "D."[255] More eye-popping than that is a recent large-scale study by researchers at Carnegie Mellon who found a "strong" correlation over a four-year period between a high school's broadband usage and declining student test scores.[256] They also found that merely blocking a school's access to YouTube caused grades to go up.[257] And cognitive load theory tells us that multitasking may have an especially deleterious effect on students who are trying to learn new things in particular because of the heavy burden it places on working memory's limited processing capabilties.[258]

Those defending classroom laptops argue that technology is not the problem; rather it is boring professors. If students are misusing laptops in class, the argument goes, it is no different than the off-task behaviors of a bygone era when bored students passed notes, read the newspaper, or stared out the window. The solution is not to ban technology but to better engage students. Part II exposes the fallacy of this argument since the caveman brain is programmed for distractibility and novelty-seeking, which the tech designers fully exploit.

No teacher, no matter how interesting, can simultaneously fight the Darwinian survival imperative served by a distracted brain *and* the evil minions of Silicon Valley.[259] And even if you were "*the most interesting man in the world*," it would not help, according to a new study that found distractions interfering with "high interest" lectures have a *greater adverse effect* on learning than those interfering with "low interest" ones.[260] It is because

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255 *See* Amanda C. Gingerich & Tara T. Lineweaver, *OMG! Texting in Class = U Fail :(Empirical Evidence that Text Messaging During Class Disrupts Comprehension*, 41 TCHR. PSYCHOL. 44, 49 (2014).

256 *See* Rodrigo Belo et al., *Broadband in School: Impact on Student Performance*, 60 MGMT. SCI. 265, 266, 274 (Feb. 2014) (four-year study of ninth grade students in large Portuguese school district found "robust" evidence of correlation between increase in broadband use and a negative effect on student grades regardless of gender and subject matter). The researchers chose ninth graders to study because that is the final year of compulsory schooling in Portugal. *Id.*

257 *Id.* at 266, 277–78; *see also Mobile Phone Bans 'Improve School Exam Results,'* BBC NEWS (May 17, 2015), http://www.bbc.com/news/education-32771253 [http://perma.cc/UP5P-6KDR] (study of four U.K. secondary school systems published by the London School of Economics found test scores increased an average of 6% following a cellphone ban, with low achieving students gaining the most).

258 *See* Lee et al., *supra* note 108, at 95–97, 101 (learning new tasks places an additional cognitive load on working memory and, thus, extraneous distractions that consume limited processing capacity can, and do, interfere with learning).

259 In an interview with the *Boston Globe*, Harvard Law Professor Zittrain described himself as an "entertaining teacher," yet conceded that he could never compete with the Internet in holding student attention. *See* Jan, *supra* note 244.

260 *See* Natasha Gupta & Julie D. Irwin, *The Role of Facebook and Primary Learning Task*, COMPUTERS HUM. BEHAV. (2014), http://www.sciencedirect.com/science/article/pii/

the former diverts a greater quantum of each student's limited attentional capacity away from learning.[261] Students also overestimate their ability to learn while multitasking so they see no reason to curb their own behavior, meaning we must do it for them.[262]

Putting laptops in the classroom yet failing to manage their use is tantamount to creating an attractive nuisance that can negatively affect every student's learning.[263] It is why, after allowing laptops for nearly two decades, Internet scholar Professor Clay Shirky of NYU recently decided to ban them, concluding "humans are incapable of ignoring" the distractions they cause.[264] And it is why former Harvard Law Professor and author of *Born Digital* John Palfrey says that "best practices" for classroom technology use in law school is about knowing when to turn it off.[265]

The reason for putting laptops in the classroom in the first place was the belief they helped inculcate students into the expectations of law practice. That made sense back in the 1990s when everyone wore flannel and Ally McBeal was still on TV. But by now wireless devices have become so ubiquitous that the rationale no longer applies. In fact, because of their ubiquity, the more pressing need today is to teach students the importance of managing their technology use so they can learn to work better and smarter.[266] Thinking like a lawyer will always require the

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"The Most Interesting Man in the World" refers to the long-running advertising campaign by Dos Equis beer in which an actor appears in a series of outrageous vignettes that always end with the tagline: "I don't always drink beer. But when I do, I prefer Dos Equis. Stay thirsty, my friends." *The Most Interesting Man in the World,* WIKIPEDIA, http://en.wikipedia.org/wiki/The_Most_Interesting_Man_in_the_World [http://perma.cc/CS34-JHLL].

261 Gupta & Irwin, *supra* note 260; *see* GALLAGHER, *supra* note 76, at 9 (paying attention means spending one's limited cognitive currency, so it should be spent wisely).

262 *See* BROWN ET AL., *supra* note 178, at 121 (discussing "Dunning-Kruger effect"); LEVITIN, *supra* note 113, at 306 (cognitive illusion, fueled by a dopamine-adrenaline feedback loop, makes multitaskers think they are doing much better than they really are); Ravizza et al., *supra* note 115, at 112; *supra,* p. 281 and note 248. Significantly, some research suggests that multitasking may have a greater adverse effect on the best students. *See* Ravizza et al., *supra* note 115, at 113.

263 *See supra* notes 249–50.

264 Shirky, *supra* note 249 (Stanford Professor Cliff Nass, an expert on human-computer interaction, has said that Internet distractions are like catnip that users cannot ignore).

265 *See* Palfrey, *supra* note 7, at 108.

266 *See* Jones & Shao, *supra* note 4, at 26 (survey of college students finds they want teachers to make only moderate use of technology); Kay & Lauricella, *supra* note 247, at 38 (research shows students want teachers to make structured use of laptops during class); Bernand McCoy, *Digital Distractions in the Classroom: Student Classroom Use of Digital Devices for Non-class Related Purposes*, 4 J. MEDIA EDUC. 5, 10 (2013) (majority of

ability to shut out distractions and focus on the task at hand.[267] If constant exposure to digital technologies is undermining our students' ability to do that, as many believe, we should create more opportunities for them to practice these vital skills, not less.[268]

Recognizing this, some law professors have proposed that schools offer meditation and mindfulness training to counterbalance the negative effects of too much technology use.[269] While these proposals are beyond the scope of this Article, suffice it to say that it is incumbent upon everyone, professors included, to develop strategies for maintaining a more balanced digital diet. When it comes to our students, a good place to start is by modeling that for them in the classroom.

C. Death by PowerPoint and Other Visual Crimes

One of the most popular assumptions about digital natives is that they are primarily visual learners who learn best with technologies like PowerPoint. That learning science confirms we are indeed highly visual creatures by design, and everyone already knows a picture is worth a thousand words, only reinforces the intuitive appeal of these beliefs.[270] On the other hand, even if learning styles existed, learning science tells us

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college students polled at six universities said they favor teacher-imposed limitations on laptop use).

267 *See* POWERS, *supra* note 5, at 76–77 (Google's CEO tells college students "turn off your computers" and "just disconnect" because it is not healthy to be plugged in all the time); Simon Baron-Cohen, *A Thousand Hours a Year*, *in* IS THE INTERNET CHANGING THE WAY YOU THINK?, *supra* note 3, at 173, 174 (persistent, frequent email threatens our capacity for real work—we need to restrict it to certain times of the day).

268 *See* GALLAGHER, *supra* note 76, at 10, 67 (mastering "focus" is a skill which, like any other, takes effort and practice to develop); POWERS, *supra* note 5, at 102 (in an always-connected world, the need to unplug and recharge is more urgent than ever); Baron-Cohen, *supra* note 267, at 174; Palfrey, *supra* note 7, at 114 (we must teach students to *unlearn* unproductive behaviors resulting from excessive technology use).

269 *See* R. Lisle Baker & Daniel P. Brown, *On Engagement: Learning to Pay Attention*, 36 U. ARK. LITTLE ROCK L. REV. 337, 357–58 (2014); Shailini Jandial George, *The Cure for the Distracted Mind: Why Law Schools Should Teach Mindfulness*, 53 DUQ. L. REV. 215, 217–20 (2015); Lauren A. Newell, *Redefining Attention (and Revamping the Legal Profession?) for the Digital Generation*, 15 NEV. L.J. 754, 793 (2015); *see also* GALLAGHER, *supra* note 76, at 73–74 ("focusing workouts" can, like meditation, increase the ability to focus); POWERS, *supra* note 5, at 219 (stating that forward thinking educators should develop quiet zones in school); Matt Richtel, *Silicon Valley Says Step Away from the Device*, N.Y. TIMES (July 23, 2012), http://www.nytimes.com/2012/07/24/technology/silicon-valley-worries-about-addiction-to-devices.html [http://perma.cc/G6MM-FA5N] (many Silicon Valley companies encourage employees to log-off; Google has even started a mindfulness program to help employees improve focus).

270 *See* CAREY, *supra* note 7, at 34; MEDINA, *supra* note 67, at 233 (stating that the more pictorial the sensory input, the more likely it will be remembered and recalled); *supra* pp. 275–76 and accompanying notes.

that we should pick methods and tools based on their compatibility with our classroom objectives, not what is most familiar or popular with students.[271] The subject matter we teach is complex and often does not lend itself to easy explanations, pictures, or bullet points.[272] If we sacrifice complexity and nuance for the sake of fitting the material onto a slide, we risk enabling lazy System 1 thinking instead of helping students build the intellectual muscles needed for System 2.

Critics of visual technologies like Professor Edward Tufte of Yale, a leading scholar on visual literacy, argue that PowerPoint undermines analytical thinking for these very reasons.[273] Others argue that "PowerPoint is quintessentially designed for one-off," shallow reading rather than deep engagement.[274] Sure, students can download and study the slides later, but how many really do, and can a slide engage students like print, which they can attack with pen and highlighter in hand?[275] There is also the temptation

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271 *See* BROWN, ET AL., *supra* note 178, at 131–32 (stating that even if learning styles existed and students were indeed visual learners, to be effective teachers must still match instructional methods with their learning objectives); *supra* p. 274 and notes 205–08.

272 *See* April Savoy et al., *Information Retention from PowerPoint and Traditional Lectures*, 52 COMPUTERS & EDUC. 858, 866 (2009) (concluding that although students said they preferred PowerPoint, test results showed a lecture is the best method when information is more amenable to dialogue or explanation).

273 EDWARD R. TUFTE, THE COGNITIVE STYLE OF POWERPOINT 4–6, 13, 26 (2003). The New York Times called Professor Tufte the "da Vinci of data." Deborah Shapley, *The da Vinci of Data*, N.Y. TIMES (Mar. 30, 1998), http://www.nytimes.com/1998/03/30/business/the-da-vinci-of-data.html [http://perma.cc/XYM7-NAV2]; *see* MOROZOV, *supra* note 196, at 248 (stating that PowerPoint feeds the demand for clarity which is about "getting to the point," but appeasing this demand sends the wrong message to students—that complex ideas can and should be crammed into bullet points); Delese Wear, *Perspective: A Perfect Storm: The Convergence of Bullet Points, Competencies, and Screen Reading in Medical Education*, 84 ACAD. MED. 1500, 1503 (2009) (postulating that the overuse of PowerPoint in medical school discourages the give and take between teacher and student by condensing knowledge and skills, "hiding nuances and complexities, simplifying relationships and flattening reflection"); Edward Tufte, *PowerPoint is Evil*, WIRED (Sept. 1, 2003, 12:00 PM), http://archive.wired.com/wired/archive/11.09/ppt2.html [http://perma.cc/UVQ4-XF8L]; Maryellen Weimer, *Does PowerPoint Help or Hinder Learning?,* FACULTY FOCUS (Aug. 1, 2012), http://www.faculty focus.com/articles/teaching-professor-blog/does-powerpoint-help-or-hinder-learning/ [http://perma.cc/2F69-5TF5] (arguing that PowerPoint oversimplifies material and encourages passivity in students).

274 *See* NAOMI S. BARON, WORDS ON SCREEN: THE FATE OF READING IN A DIGITAL WORLD 99 (2015); Ruth H. Moody & Michael Bobic, *Teaching the Net Generation Without Leaving the Rest of Us Behind: How Technology in the Classroom Influences Student Composition*, 39 POL. & POL'Y 169, 182–83 (2011) (researchers have known for decades that visual modalities do not engage students as deeply with respect to higher ordered thinking because visual stimuli do not work on the parts of the brain needed for the kind of thinking college professors expect); Wear, *supra* note 273, at 1501–03.

275 *See* BARON, *supra* note 274, at 99; Rim M. El Khoury & Dorine M. Mattar, *PowerPoint in Accounting Classrooms: Constructive or Destructive?,* 3 INT. J. BUS. & SOC. SCI. (SPECIAL ISSUE) 242 (2012) (discussing a survey that found many students are less likely to be engaged in class if they know they can download the PowerPoint slides later); Moody & Bobic, *supra* note 274, at 182–83; Daniel Sewasew et al., *A Comparative Study*

to overuse these tools to meet the expectations of students who may have grown accustom to them as undergraduates.[276]

With those important caveats in mind, pictures can in fact be very effective teaching tools precisely because the brain is so visually oriented.[277] But we need a strategy for deciding whether they are the best ones for the job to avoid the aforementioned risks.[278] The best place to start is by asking whether a visual can adequately communicate the material in all its complexity and nuance compared to the alternatives. Related to that, we should ask whether a visual modality promotes the effortful engagement required by System 2 thinking rather than reinforcing facile caveman thinking.[279] Remember too that pictures are often ambiguous, which is why they need captions, so we need to consider whether the ones we plan to use communicate the ideas with precision and clarity.[280]

To take an example from my own teaching, I use a visual to explain to my 1Ls the concept of inferential thinking because I believe it works better than the alternatives. I show students a picture of footprints in the sand and then ask whether we can all agree that someone was recently walking there, even though we never saw them nor do we have any eyewitnesses to ask. They instantly "get it" because the visual explains the idea more succinctly and clearly than I can with words.

In perhaps the definitive article on using PowerPoint in law school, Professor Deborah J. Merritt describes a torts class in which she teaches battery by showing students a picture of one child kicking another to illustrate the facts of *Vosburg v. Putney*.[281] She explains that a well-chosen visual embodying all elements of a claim can work as a chunking technique to help

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on PowerPoint Presentation and Traditional Lecture Method in Material Understandability, Effectiveness and Attitude, 10 EDUC. RES. & REV. 234, 241–42 (2015) (noting a survey of foreign university students which found that the majority believe they learn less with PowerPoint compared to lectures).

276 *See* Wear, *supra* note 273, at 1501 (busy faculty are seduced by technology that offers an easy default to construct their lectures, but it is a format that does not easily encourage the give and take necessary to grapple with challenging material).

277 *See* MEDINA, *supra* note 67, at 233; *supra* note 270.

278 *See* Emerling, *supra* note 9 (unlike American educators, the Japanese take a meticulous, studied approach to deciding whether digital technology or the traditional chalkboard better serves the classroom goal).

279 *See supra* pp. 270–72 and accompanying notes.

280 *See* PINKER, *supra* note 10, at 297–98; Savoy, *supra* note 272, at 866 (concluding that dialogue and explanation are often better than pictures when teaching certain subjects).

281 Vosburg v. Putney, 50 N.W. 403, 403 (Wis. 1891); *see* Deborah J. Merritt, *Legal Education in the Age of Cognitive Science and Advanced Classroom Technology*, 14 B.U. J. SCI. & TECH. L. 39, 52–53 (2008).

students process a larger volume of information that might otherwise overwhelm working memory.[282] An added benefit is that a visual can provide a vivid, memorable reference point to anchor further class discussion about any of the issues later in the semester.[283]

Assuming a visual is compatible with the teacher's objectives, the next step is to pick images that are both memorable and meaningful. The importance of using memorable visuals is obvious enough, but they should also be meaningful insofar as they serve as a familiar reference point for students.[284] This will help students connect the material to their existing schemas.[285] Thus, meaningful images can deepen understanding while those that merely grab attention may be counterproductive if they overshadow the underlying point.[286]

Next, designing good visuals is about keeping them simple.[287] PowerPoint comes with lots of special effects like sounds and animation that can liven up a slideshow while also turning it into a multimodal learning tool.[288] However, students say they get distracted by special effects unrelated to the content of the slides.[289] And using too many special effects may also overwhelm working memory such that the underlying point is lost.[290]

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282 *See* Merritt, *supra* note 281, at 51–52; *supra* pp. 259–60 and notes 110–12.

283 Merritt, *supra* note 281, at 53; *see also* CAREY, *supra* note 7, at 34 (stating that the human brain's recall for images is strong).

284 Merritt, *supra* note 281, at 50; *see also* CAREY, *supra* note 7, at 34; KAHNEMAN, *supra* note 71, at 322–23 (because the brain is so visually oriented, it makes images highly accessible); MEDINA, *supra* note 67, at 114.

285 Merritt, *supra* note 281, at 50; *see also* MEDINA, *supra* note 67, at 114–15; *supra* p. 255 and note 72; *supra* pp. 258–59 and accompanying notes.

286 Merritt, *supra* note 281, at 56–57; *see also* Ruth Colvin Clark & Richard E. Mayer, *Using Rich Media Wisely, in* TRENDS AND ISSUES IN INSTRUCTIONAL DESIGN AND TECHNOLOGY 311, 319 (Robert A. Reiser & John V. Dempsey eds., 2d ed. 2006) (citing research that interest-grabbing features in textbooks do more harm than good because students may remember those features yet fail to learn the material); Richard E. Mayer & Roxana Moreno, *A Split-Attention Effect in Multimedia Learning: Evidence for Dual Processing Systems in Working Memory*, 90 J. EDUC. PSYCHOL. 312, 312, 315–16 (1998).

287 Merritt, *supra* note 281, at 56; *see also* Jean-Luc Doumont, *The Cognitive Style of PowerPoint: Slides Are Not All Evil*, 52 TECH. COMM. 64, 68 (2005) (PowerPoint slides are often ineffective because they contain unnecessary clip art, sounds, colors, and other "noninformation" that is unrelated to the content).

288 *See* Merritt, *supra* note 281, at 47 (denoting several experiments that show students who simultaneously process information through visual and auditory channels learn better than those who process it only visually); *supra* p. 259 and note 102.

289 *See* Jennifer M. Apperson et al., *An Assessment of Student Preferences for PowerPoint Presentation Structure in Undergraduate Courses*, 50 COMPUTERS & EDUC. 148, 153 (2008) (citing a survey of college students that found they like sound effects when congruent with slide content but otherwise found them distracting).

290 Merritt, *supra* note 281, at 56; *see* Apperson et al., *supra* note 289, at 153; Doumont, *supra* note 287, at 68.

Keeping things simple also means minimizing text as it defeats the purpose of using visuals in the first place.[291] If it takes a lot of words to communicate the point, perhaps the whiteboard, lecture, or handout is a better alternative.[292] Similar to using too many special effects, research suggests that slides containing too much text can interfere with working memory because students tend to read the words to themselves while listening to the professor's explanation.[293] Professor Merritt explains this can focus the brain on comparing the two narratives, which may overwhelm working memory and disrupt learning.[294]

Text-heavy slides can also undermine critical thinking skills for reasons alluded to by the critics.[295] A key part of training students to "think like a lawyer" is helping them see complexity where others do not.[296] Good lawyers take what at first seems like a straightforward legal issue and peel away the layers to expose additional issues and nuance. Reducing class material to a set of pithy bullet points by word and deed contradicts this vital lesson.[297]

Finally, keep in mind there are good reasons for the euphemism "death by PowerPoint." Standing behind the podium while clicking through slides that students can ignore for now

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291 *See* MEDINA, *supra* note 67, at 234, 238–39 (visuals work because they have cognitive processing advantages over text, so if you are going to use PowerPoint, burn your old slides and start over by substituting pictures for words); Doumont, *supra* note 287, at 68; Merritt, *supra* note 281, at 52; *cf.* Apperson, *supra* note 289, at 152 (noting that undergraduate students said they "strongly prefer" the teacher to use "key phrases" in their slides).

292 Merritt, *supra* note 281, at 55; *see infra* p. 290 and notes 302–04.

293 *See* Merritt, *supra* note 281, at 57–58; Doumont, *supra* note 289, at 68; Slava Kalyuga et al., *When Redundant On-Screen Text in Multimedia Technical Instruction Can Interfere with Learning*, 46 HUM. FACTORS 567, 576–78 (2004) (finding that students who read description while listening to the teacher's explanation found it more challenging than students who simply listened); Savoy et al., *supra* note 272, at 866.

294 Merritt, *supra* note 281, at 47, 57–58; *see also* Richard E. Mayer, *Cognitive Theory of Multimedia Learning, in* THE CAMBRIDGE HANDBOOK OF MULTIMEDIA LEARNING 31, 46, 47 (Richard E. Mayer ed., 2005); Kalyuga, *supra* note 293, at 576–78; Savoy, *supra* note 272, at 866 (stating that teachers should avoid explaining material while showing PowerPoint slides because it can interfere with learning information that is best communicated through "dialogue or verbal explanation"); Doumont, *supra* note 287, at 68.

295 *See* TUFTE, *supra* note 273, at 4–6, 13, 26; El Khoury & Mattar, *supra* note 275, at 242, 254; Wear, *supra* note 273, at 1501, 1503.

296 *See* MOROZOV, *supra* note 196, at 248–49 (arguing that any learning enterprise that begins with the assumption that "ideas" have a "bottom line" does not turn out talented, creative thinkers).

297 *See id.* at 248 (clarity as a pedagogical goal is overemphasized; the demand for it by students should not come at the expense of helping them appreciate the complexity of ideas); Wear, *supra* note 273, at 1503 (stating that a medical school professor worries that overuse of PowerPoint eliminates complexity and nuance from the classroom).

and download later packs all the dynamism of watching paint dry.[298] In fact, it can put bleary-eyed law students to sleep.[299] Professor Merritt points out that when the lights are down low and all eyes are focused on the screen, student-teacher interaction grinds to a halt.[300] Not surprisingly, some college students say PowerPoint turns them into passive observers who are less likely to interrupt the teacher to ask questions.[301]

For all these reasons, never overlook the whiteboard as a better alternative. Just as PowerPoint can feel scripted and stiff, using the whiteboard more closely follows the natural rhythm of a conversation between teacher and students. A "chalk-talk" is also a multimodal learning experience because even watching physical activity like a teacher writing on the board is processed by the brain differently than looking at slides.[302] The former creates motor memories in addition to visual ones, which experts say may enhance retention and recall.[303] It is consistent with surveys finding that students learn better and are more engaged watching a "chalk-talk" than PowerPoint.[304] If nothing else, using

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298 *See* El Khoury & Mattar, *supra* note 275, at 242 (noting surveys that find students are less likely to take notes, and more likely to skip class, if they know they can review slides later).

299 *See id.* (PowerPoint can make students sleepy due to the need to dim the lights to view it); *see also* Sewasew et al., *supra* note 275, at 239.

300 Merritt, *supra* note 281, at 58; *see also* Douglas L. Leslie, *How Not to Teach Contracts, and Any Other Course: PowerPoint, Laptops, and the Casefile Method*, 44 ST. LOUIS U. L.J. 1289, 1304 (2000) (noting that laptops and PowerPoint destroy teacher-student interaction); Maxwell, *supra* note 60, at 4 (classroom laptops in law school interfere with teacher-student interaction and rapport); El Khoury & Mattar, *supra* note 275, at 242; Sewasew et al., *supra* note 275, at 235. *But see* Apperson, *supra* note 289, at 153 (college students said they like the teacher to dim the lights because they can see the slides better).

301 El Khoury & Mattar, *supra* note 275, at 242; *see also* Emerling, *supra* note 9 (in tech-obsessed Japan, teachers often favor traditional chalkboards over visual aids because research shows it to be a modality that is better suited to certain subject matter, like math).

302 *See* Anne Mangen & Jean-Luc Velay, *Digitizing Literacy: Reflections on the Haptics of Writing*, *in* ADVANCES IN HAPTICS 385, 390, 394 (Mehrdad Hosseini Zadeh ed., 2010) [hereinafter Mangen & Velay, *Digitizing Literacy*]; Trond Egil Toft, *Better Learning Through Handwriting*, SCIENCEDAILY (Jan. 24, 2011), http://www.sciencedaily.com/releases/2011/01/110119095458.htm [https://perma.cc/6D3Y-CST3?type=image] (research shows merely watching physical activity lights up areas of the brain associated with sensorimotor functions, meaning the information is processed as both visual and physical sensory data leaving both kinds of memories).

303 *See* Mangen & Velay, *Digitizing Literacy*, *supra* note 302, at 394; Toft, *supra* note 302.

304 *See* El Khoury & Mattar, *supra* note 275, at 254 (citing a survey of foreign university students); Nozar Hashemzadeh & Loretta Wilson, *Teaching with the Lights out: What Do We Really Know About the Impact of Technology Intensive Instruction?*, 41 C. STUDENT J. 601, 608, 611 (2007) (analyzing a survey of U.S. college students); Sewasew et al., *supra* note 275, at 241 (noting that foreign university students say a chalk-talk has greater immediacy than looking at the screen in a darkened room); Krishna T. Vamshi et

the whiteboard also creates an incentive for students to pay attention and take good notes because unlike PowerPoint, what the teacher writes and says cannot be downloaded later.[305]

D. The King is Dead, Long Live the King: Books and Screens

Teaching students critical reading skills has always been a central goal of a legal education. Due to the falling credentials of entering law students because of the sharp drop in applications, along with a four-decade decline in national reading scores, this task has become even more challenging.[306] The only technology issue this raises is whether to emphasize screens, print, or a combination of the two. The term "digital native" suggests this is a nonstarter since today's students supposedly only read electronic media and consider print an antiquated format they won't go near. Like other assumptions about digital natives, this may be more cliché than fact.

Numerous polls of university students find that the majority still prefers print for schoolwork believing it helps them learn better.[307] Even surveys of tech-savvy teens show that some like

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al., *Comparative Study on the Teaching Effectiveness of Chalk & Talk and Microsoft PowerPoint Presentation from the Student Perspective,* INT'L J. PHARMACY & PHARMACEUTICAL SCI., Jan.–Mar. 2011, at 191, 192 (containing a survey of foreign university students); *see also* Emerling, *supra* note 9.

305 *See* El Khoury & Mattar, *supra* note 275, at 242; *supra* p. 289 and note 297.

306 *See* Silver, *supra* note 11, at 387–89; Lyndsey Layton & Emma Brown, *SAT Reading Scores Hit a Record Four-Decade Low*, WASH. POST (Sept. 24, 2012), http://www.washingtonpost.com/local/education/sat-reading-scores-hit-a-four-decade-low/2012/09/24/7ec9cb1e-0643-11e2-afff-d6c7f20a83bf_story.html [http://perma.cc/ZK5N-L54Z].

307 *See* BARON, *supra* note 274, at 80, 83, 171, 214 (stating that students "overwhelmingly" prefer traditional books for pleasure reading except for the news, which they read online); Sung Woo Ji et al., *Print vs. Electronic Readings in College Courses: Cost-Efficiency and Perceived Learning,* 21 INTERNET & HIGHER EDU. 17, 22–23 (2014) (finding that college students prefer free electronic readings due to cost but vast majority say they study more and learn better with print); Diane Mizrachi, *Undergraduates' Academic Reading Format Preferences and Behaviors*, 41 J. ACAD. LIBRARIANSHIP 301, 310 (2015) (containing a survey of UCLA undergrads which found they overwhelmingly prefer print for deep reading); M. Julee Tanner, *Digital vs. Print: Reading Comprehension and the Future of the Book*, 4 SCH. STUDENT RES. J., no. 2, 2014, at 1, 4 (claiming that digital natives report in survey after survey they prefer print for school work); William D. Woody et al., *E-Books or Textbooks: Students Prefer Textbooks*, 55 COMPUTERS & EDUC. 945, 947 (2010) (finding that tech savvy college students prefer print to e-text even though they are comfortable with and used to an electronic medium); Angela Chen, *Students Find E-Textbooks 'Clumsy' and Don't Use Their Interactive Features,* CHRON. HIGHER EDUC. (Aug. 22, 2012), http://chronicle.com/blogs/wiredcampus/students-find-e-textbooks-clumsy-and-dont-use-their-interactive-features/39082 [http://per ma.cc/HME8-SAWW] (students polled at several universities said they like the cheaper cost of e-textbooks but prefer print for academic work); Ferris Jabr, *The Reading Brain in the Digital Age: The Science of Paper Versus Screen*, SCI. AM. (Apr. 11, 2013), http://www.scientificamerican.com/article/reading-paper-screens/ [http://perma.cc/J2LP-LRLL]; Teri Tan, *College Students Still Prefer Print Textbooks,* PUBLISHERS WEEKLY (July 8, 2014), http://www.publishersweekly.com/pw/by-topic/digital/

print more than their parents.[308] Only a short time ago it seemed certain e-books would do to print what the mp3 did to the music industry, yet sales have already plateaued or even declined, some sources believe.[309] Technology stars like Bill Gates prefer print for deep reading, and Steve Jobs refused to let his own children use an iPad to read.[310] Silicon Valley top executives send their kids to a private school where print is king and computers are banned.[311] And many people who read and think for a living, like

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content-and-e-books/article/63225-college-students-prefer-a-mix-of-print-and-digital-text books.html [http://perma.cc/VBC5-DNJZ]; Jeffery R. Young, *Students Remain Reluctant to Try E-Textbooks, Survey Finds,* CHRON. HIGHER EDUC. (Oct. 26, 2010), http://chronicle.com/blogs/wiredcampus/students-remain-reluctant-to-try-e-textbooks-survey-finds/27866 [http://perma.cc/U9DX-L6CS] (vast majority of college students prefer print to e-books based on nationwide survey by National Association of College Stores); Mikayla Nicole Byars, Printed Books Versus Digital Books (June 2015) (unpublished senior thesis, California Polytechnic State University, San Luis Obispo), http://digital commons.calpoly.edu/cgi/viewcontent.cgi?article=1147&context=grcsp [http://perma.cc/LH M5-HEE6] (containing a survey of Cal Poly students which found 70% of students preferred print for classwork and over 80% preferred it for pleasure reading). *But see* Edward W. Walton, *Why Undergraduate Students Choose to Use E-books*, 46 J. LIBRARIANSHIP & INFO SCI. 263, 267 (2014) (containing a survey of undergraduate students that found "[s]tudents' use of e-books was positively related to leisure reading and conducting research").

308 *Don't Judge a Book by Its Cover: Tech-Savvy Teens Remain Fans of Print Books,* NIELSEN (Dec. 9, 2014), http://www.nielsen.com/us/en/insights/news/2014/dont-judge-a-book-by-its-cover-tech-savvy-teens-remain-fans-of-print-books.html [http://perma.cc/Z7Q N-E7AF]; *see* Charlotte Eyre, *Nearly Three Quarters of Young People Prefer Print*, BOOKSELLER (Sept. 25, 2014), http://www.thebookseller.com/news/nearly-three-quarters-young-people-prefer-print [http://perma.cc/B23B-T5V2] (survey of sixteen to twenty-four year old British youths find 73% prefer print to e-books). *But see* Åse Kristine Tveit & Anne Mangen, *A Joker in the Class: Teenage Readers' Attitudes and Preferences to Reading on Different Devices*, 36 LIBR. & INFO. SCI. RES. 179, 182–83 (2014) (stating that tenth grade Norwegian students who are not "devoted readers" prefer e-books).

309 *See* BARON, *supra* note 274, at 191–92 (stating that although e-book sales figures are a well-kept trade secret, the author estimates they comprise approximately 20% of the total book market and may have already peaked); Tanner, *supra* note 307, at 1; *BookStats: Ebooks Flat in 2013*, DIGITALBOOKWORLD (June 26, 2014), http://www.digitalbookworld.com/2014/bookstats-ebooks-flat-in-2013/ [http://perma.cc/VV6 Y-6WVJ]; Andrew Trotman, *Kindle Sales Have 'Disappeared,' Says UK's Largest Book Retailer,* THE TELEGRAPH (Jan. 6, 2015), http://www.telegraph.co.uk/finance/newsbysector/retailandconsumer/11328570/Kindle-sales-have-disappeared-says-UKs-largest-book-retailer.html [http://perma.cc/87NE-T5T3].

310 *See* Robert Darnton, THE CASE FOR BOOKS: PAST, PRESENT, AND FUTURE 69 (2009) (Bill Gates states screens are "vastly inferior" to print); Nick Bilton, *Steve Jobs Was a Low-Tech Parent*, N.Y. TIMES (Sept. 10, 2014), http://www.nytimes.com/2014/09/11/fashion/steve-jobs-apple-was-a-low-tech-parent.html?_r=0 [https://perma.cc/5W7N-CG3H] (Jobs telling interviewer he never let his kids use the iPad).

311 Matt Richtel, *A Silicon Valley School that Doesn't Compute*, N.Y. TIMES (Oct. 22, 2011), http://www.nytimes.com/2011/10/23/technology/at-waldorf-school-in-silicon-valley-technology-can-wait.html?pagewanted=all&_r=0 [https://perma.cc/433V-BHCS] (stating that at Silicon Valley's Waldorf School students read books, write with pen and paper, and are even discouraged from using computers at home).

researchers, scientists, and scholars, prefer books for deep reading and screens for everything else.[312]

A small but growing body of research so far confirms the anecdotal evidence that print is more compatible with the higher-ordered, critical thinking and reading skills we teach in law school.[313] Studies show that students reading print

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312 *See* BARON, *supra* note 274, at xi, 146; Esther de Groot, *Problematic Screen Reading: Is It Caused by Our Brain?*, TXTLEIDEN, http://www.txtleiden.org/2014/problematic-screen-reading [http://perma.cc/EF4F-2G3H] (noting that expert readers like print so they can "study" it, flick the text back and forth, highlight, and annotate it); Terje Hillesund, *Digital Reading Spaces: How Expert Readers Handle Books, the Web and Electronic Paper*, FIRST MONDAY (Apr. 5, 2010), http://firstmonday.org/article/view/2762/2504 [http://perma.cc/VE2J-G9MF]; Ziming Liu, *Reading Behavior in the Digital Environment: Changes in Reading Behavior over the Past Ten Years*, 61 J. DOCUMENTATION 700, 704–09 (2005) (finding that thirty to forty-five-year-old professional readers use screens to browse but print for deep reading); Julie Waters et al., *A Comparison of E-book and Print Book Discovery, Preferences, and Usage by Science and Engineering Faculty and Graduate Students at the University of Kansas*, ISSUES SCI. & TECH. LIBRARIANSHIP (Winter 2014), http://www.istl.org/14-winter/refereed3.html [http://perma.cc/E3XT-CCMM] (survey of science and engineering faculty that found preference for print over screen varies from 52% to 80% depending on department); Panayiotes Tryphonopoulos, From the Screen to the Page: A Qualitative Study of Reading Experiences of University Faculty 75, 87 (April 2015) (unpublished master thesis, University of New Brunswick), https://unbscholar.lib.unb.ca/islandora/object/unbscholar%3A6593 [https://perma.cc/X3Y2-KVM8] (survey of "professional readers" that found they prefer a hybrid approach that makes use of screens for short texts and skimming and print for deep reading).

313 *See* BARON, *supra* note 274, at 165, 213 (summarizing learning-related advantages of print over screens); Rakefet Ackerman & Tirza Lauterman, *Taking Reading Comprehension Exams on Screen or on Paper? A Metacognitive Analysis of Learning Texts Under Time Pressure*, 28 COMPUTERS HUM. BEHAV. 1816, 1826 (2012) (finding that print has metacognitive advantages over screens leading to stronger test scores for comprehension and retention); Rakefet Ackerman & Morris Goldsmith, *Metacognitive Regulation of Text Learning: On Screen Versus on Paper*, 17 J. EXPERIMENTAL PSYCHOL. APPLIED 18, 28–30 (2011) (finding that screens can hurt comprehension by leading to overconfidence in reading ability); Anne Mangen et al., *Reading Linear Texts on Paper Versus Computer Screen: Effects on Reading Comprehension*, 58 INT'L J. EDUC. RES. 61, 65, 67 (2013) (finding that print readers performed "significantly better" in each of the two reading genres tested); Jabr, *supra* note 307 (citing numerous studies showing cognitive advantages of print over screens); *see also* Ji et al., *supra* note 307, at 23 (reporting that students say they study and learn more using print rather than screens).

On the other hand, some studies have found no difference between the formats. *See* Sara J. Margolin et al., *E-readers, Computer Screens, or Paper: Does Reading Comprehension Change Across Media Platforms?,* 27 APPLIED COGNITIVE PSYCHOL. 512, 517–18 (2013) (finding no difference in reading comprehension between formats in a study that tested college students on ten short passages); Kaveri Subrahmanyam et al., *Learning from Paper, Learning from Screens: Impact of Screen Reading and Multitasking Conditions on Reading and Writing Among College Students*, INT'L J. CYBER BEHAVIOR, PSYCHOL. & LEARNING, Oct.–Dec. 2013, at 1, 24 (finding no difference in reading comprehension between print and screens). To the extent these studies appear to conflict, experts say it may be due to significant differences between them with respect to the length of the reading passages used, their difficulty, the time constraints placed on students, whether they were tested immediately after they read the material or days later, the genres used, whether students were asked to read for pleasure or for school as well as a host of other factors. *See* Anne Mangen & Jean-Luc Velay, *Cognitive* outperform those reading screens on tests that measure both comprehension and retention.[314] In some cases, the differences were significant.[315] Some experts characterize the difference as those who read print *understand* what they have read, while those reading screens merely remember it.[316]

Other studies find that print is a more immersive experience compared to screens and even dedicated e-reading devices.[317]

Implications of New Media, in THE JOHNS HOPKINS GUIDE TO DIGITAL MEDIA 72, 75 (Marie-Laure Ryan et al. eds., 2014). Further, some of these studies found no differences in the formats by relying on students' final course grades as a proxy for learning rather than more objective forms of assessment or evaluation.

In comparison, Professor Mangen, one of the leading authorities on reading technologies, has studied the differences between print and screens on learning using longer, more substantial texts that may be closer to approximating the reading assignments used in law school. *See* Mangen & Kuiken, *supra* note 4, at 157, 164–67 (finding print has cognitive advantages compared to screens when subjects tested on five- to seven and one-half-page literary short stories); Alison Flood, *Readers Absorb Less on Kindles than on Paper, Study Finds*, GUARDIAN (Aug. 19, 2014), http://www.theguardian.com/books/2014/aug/19/readers-absorb-less-kindles-paper-study-plot-ereader-digitisation [http://perma.cc/33SA-NCQX] (reporting on research by Professor Mangen finding that print has cognitive advantages compared to screens when subjects were tested on a twenty-eight page mystery story).

314 *See* BARON, *supra* note 274, at 83, 170–71, 217; Ackerman & Lauterman, *supra* note 313, at 1826 (print has metacognitive advantages over screens leading to better comprehension and retention); Mangen et al., *supra* note 313; Tanner, *supra* note 307, at 4–5; Flood, *supra* note 313 (reporting results of 2014 study finding print readers performed better than Kindle readers when tested on recall of a twenty-eight-page story); Jabr, *supra* note 307; *cf.* Guang Chen et al., *A Comparison of Reading Comprehension Across Paper, Computer Screens, and Tablets: Does Tablet Familiarity Matter?*, 1 J. COMPUTER EDUC. 214, 220, 222 (2014) (containing a study comparing comprehension scores of students asked to read short passages that found those reading print scored "significantly" better on "shallow" comprehension, but no difference in "deep" comprehension, leading researchers to surmise that the test was not adequately designed to measure deep understanding and, thus, the results are unreliable); Subrahmanyam et al., *supra* note 313, at 24 (finding no difference between formats when students tested on "simple, familiar, or low-stakes" reading). *But see* Margolin et al., *supra* note 313, at 514, 517–18 (discovering no difference in reading comprehension scores when students tested on ten short passages); Amanda J. Rockinson-Szapkiw et al., *Electronic Versus Traditional Print Textbooks: A Comparison Study on the Influence of University Students' Learning*, 63 COMPUTERS & EDUC. 259, 264 (2013) (observing no difference between screens and print based on student self reporting and a review of their course grades). For an explanation on reconciling these results, see *supra* note 313.

315 *See* Mangen et al., *supra* note 313, at 67; Flood, *supra* note 313; *cf.* Chen et al., *supra* note 314, at 220, 222. *But see* Jordan T. Schugar et al., *A Nook or a Book?: Comparing College Students' Reading Comprehension Levels, Critical Reading, and Study Skills*, 7 INT'L J. TECH. TEACHING & LEARNING 174, 183–84 (2011) (finding in a study of freshman university students there was no difference in comprehension and recall scores between e-readers and print, but researchers acknowledged that overall student test results reflected poor aptitude, a general failure to critically evaluate the reading, and low motivation suggesting the results may be unreliable).

316 BARON, *supra* note 274, at 170; Tanner, *supra* note 307, at 6; de Groot, *supra* note 312; Jabr, *supra* note 307.

317 *See* BARON, *supra* note 274, at 165, 169–70 (summarizing studies); Mangen et al., *supra* note 313, at 67; Mangen & Kuiken, *supra* note 4, at 160, 162–63 (studying university students reading a non-fiction story in print format versus on an iPad and

Thus, students reading print show more empathy and are more transported by the material, which are both indications of deeper engagement.[318] Another study found that students reading a print version of a twenty-eight-page story performed significantly better when tested about its chronology compared to those who read it on a Kindle.[319] Particularly significant is research suggesting students who read screens may be less likely to finish the material and even if they do, they may be less likely to re-read it.[320] The implication is that screens are for one-off reading while we linger over print and engage with it more deeply.[321]

Experts explain these results by saying that print is processed by the brain as both a visual and haptic, or physical, experience, making it a multimodal learning tool.[322] In comparison, screen reading is processed primarily as a visual experience.[323] Even dedicated e-reading devices that are held like a book and have other features designed to replicate print such as the ability to turn pages, highlight, and write margin notes do not provide the same haptic experience as books.[324]

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finding that they had more narrative coherence, transportation, and sympathy when using the former); Jabr, *supra* note 307.

318 *See* BARON, *supra* note 274, at 149, 213; Mangen & Kuiken, *supra* note 4, at 153 (being transported by a fictional or nonfictional narrative means a reader is more immersed in it); Flood, *supra* note 313.

319 *See* Flood, *supra* note 313 (discussing a 2014 study by Professor Mangen); *cf.* Mangen & Kuiken, *supra* note 4, at 162–64; Jabr, *supra* note 307.

320 *See* BARON, *supra* note 274, at 82–83, 108; de Groot, *supra* note 312 (citing a study which found that screen readers take short cuts); Jabr, *supra* note 307; Ji et al., *supra* note 307, at 23 (stating that students say they study and learn more reading print than screens); Reynol Junco & Candrianna Clem, *Predicting Course Outcomes with Digital Textbook Usage Data*, 27 INTERNET & HIGHER EDUC. 54, 59 (2015) (discussing research showing that university students spend little time reading their digital textbooks). This is a highly significant point given a recent study finding that the amount of time students spend engaged in their class reading assignments may be the best predicator of course outcomes, even more so than their prior grades. *See* Junco & Candriana, *supra*, at 57–58 (discussing a study analyzing student reading practices using data from a CourseSmart e-textbook, the first commercially available product to offer user reading analytics).

321 *See* BARON, *supra* note 274, at 82–83, 108; de Groot, *supra* note 312; Jabr, *supra* note 307; Ji et al., *supra* note 307, at 23.

322 *See* Mangen et al., *supra* note 313, at 66; Flood, *supra* note 313 (the haptic characteristics of a Kindle do not support the same mental reconstruction of a story's chronology as print); Andrew Piper, *Out of Touch: e-Reading Isn't Reading,* SLATE (Nov. 15, 2012, 5:22 AM), http://www.slate.com/articles/arts/culturebox/2012/11/reading_on_a_kindle_is_not_the_same_as_reading_a_book.single.html [http://perma.cc/2BJ7-Q9XM] ("Reading isn't only a matter of our brains; it's something that we do with our bodies.").

323 *See* Mangen et al., *supra* note 313, at 62, 66–67 (even comparing visual characteristics, screens are still inferior to print); Jabr, *supra* note 307 (despite the name "touch screen," e-text is ephemeral and lacks the tactile qualities of print).

324 Mangen & Velay, *supra* note 313, at 74–75; Flood, *supra* note 313; Jabr, *supra* note 307.

The field of educational haptics, which examines how touch affects cognition and learning, has been largely overlooked by learning science.[325] This is odd because haptics plays a major role in learning, in some contexts more than vision.[326] Touch is the only sense that interacts with the physical world, and can even manipulate or change it, in comparison to passive senses like hearing and vision.[327] Haptics relates to the theory of embodied cognition by recognizing a mind-body connection in all cognitive activity leading some experts to advise that teaching tools incorporating physical characteristics, like books, can promote deeper engagement and understanding than purely visual ones.[328]

Haptics explains why books provide the reader with a better sense of chronology and organization than screens because they afford both a physical and visual sense of moving through the story.[329] This creates sensorimotor memories in addition to visual ones that may enhance understanding compared to a screen.[330] The physicality of books may also activate ancient brain circuitry devoted to language from the time when our ancestors communicated via gestures.[331] Thus, the caveman brain may process print in ways that connect it to language, which improves retention and recall making it a completely different experience than reading a screen.[332]

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325 Mangen & Velay, *supra* note 302, at 392; Minogue & Jones, *supra* note 234, at 317–19, 326.

326 *See* RATEY, *supra* note 76, at 180 (extensive links exist between physical movement and learning); SYLWESTER, *supra* note 49, at 56–57 (stating that the skin is where the brain meets the outside world); WILSON, *supra* note 224, at 286, 289; Mangen & Velay, *supra* note 302, at 394–95; Minogue & Jones, *supra* note 234, at 317–19, 326, 331–32 (showing that haptics is superior to vision in some contexts and is involved in all learning).

327 Minogue & Jones, *supra* note 234, at 318.

328 *See* WILSON, *supra* note 224, at 286, 289; Mangen & Velay, *supra* note 302, at 392–95; Minogue & Jones, *supra* note 234, *passim* (including haptic considerations in teaching methodologies can improve learning); *see also* Tanner, *supra* note 307, at 9; Flood, *supra* note 313; Jabr, *supra* note 307.

329 BARON, *supra* note 274, at 170; Mangen et al., *supra* note 313, at 66; de Groot, *supra* note 312; Flood, *supra* note 313; Jabr, *supra* note 307.

330 Anne Mangen & Theresa S. Schilhab, *An Embodied View of Reading: Theoretical Considerations, Empirical Findings, and Educational Implications, in* SKRIV! LES! 285, 292–93 (Synnøve Matre & Atle Skaftun eds., 2012) (finding that our physical, sensorimotor interactions with e-books are very different than the way we interact with traditional print books); Mangen & Velay, *supra* note 302, at 393–95. *See generally* Minogue & Jones, *supra* note 234.

331 *See* Hillesund, *supra* note 312; *see also* RATEY, *supra* note 76, at 180, 270; Keim, *supra* note 224, at 58 (citing studies where researchers tested children learning to write and found a relationship between the physical aspects of writing and brain activity related to language); *supra* p. 176 and accompanying notes.

332 *See* Hillesund, *supra* note 312; *supra* notes 310–14.

Print is also a more immersive experience because it lacks the distractions of electronic media such as hyperlinks and email that pull the reader away from the text.[333] One neuroscientist leading a "slow reading" movement says that because of this, reading a book for just thirty to forty-five minutes a day can restore the loss of attentional abilities due to digital devices.[334] That alone is reason enough to emphasize print more often as a training tool to help students strengthen these key skills. Apart from the haptic advantages, some experts believe that the greater visual focus, concentration, and eye-hand coordination needed to highlight, write margin notes, and turn pages are further reasons why books engage us as a visual medium more so than screens.[335]

This is not to say we should eliminate electronic text from the classroom, as if that were even feasible. To the contrary, screens are the best, most efficient tools for reviewing large volumes of material quickly, such as when doing legal research. E-books in particular also have great potential to provide analytical data on student reading practices that could help inform our teaching, course design, and predict learning outcomes.[336] On the other hand, going paperless is not a good classroom strategy either given print's superiority as a reading medium. And despite initial predictions to the contrary, it is unlikely print is going to disappear anytime soon.[337] For all these reasons, this Article recommends adopting the same hybrid reading style used by other professional readers by emphasizing

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333 *See* BARON, *supra* note 274, at 88–89, 211, 214 (discussing studies that have repeatedly shown that if an e-reading device has an Internet connection, it is more challenging to read than a book); LEVITIN, *supra* note 113, at 98 (deciding whether to open e-messages while reading depletes cognitive energy); Mangen & Velay, *supra* note 313, at 74 (stating that many studies show that navigating hyper-texted documents causes cognitive overload). Experts tell us that each time a hyperlink is encountered, the reader must evaluate it; a problem solving task that is extraneous to the content and thus saps cognitive energy. Even if the reader chooses not to follow it, making that decision still expends cognitive energy that would otherwise be directed toward the text. *See* Tanner, *supra* note 307, at 5.

334 *See* Rachel Grate, *Science Has Great News for People Who Read Actual Books*, MIC (Sept. 22, 2014), http://mic.com/articles/99408/science-has-great-news-for-people-who-read-actual-books [http://perma.cc/YAZ9-23XK].

335 *See* Hillesund, *supra* note 312.

336 *See* Junco & Clem, *supra* note 320, at 54–55; *see also* Yungwei Hao & Kathy Jackson, *Student Satisfaction Toward e-Textbooks in Higher Education*, 5 J. SCI. & TECH. POL'Y MGMT. 231, 242 (2014) (stating that with improved design, e-books could have great potential as powerful, interactive learning tools).

337 *See* BARON, *supra* note 274, at 222; DARNTON, *supra* note 310, at xiv (looking at the history of technology suggests books will coexist with electronic media); POWERS, *supra* note 5, at 147–50 (discussing "buggy whip" trope that new technology makes old instantly obsolete rarely happens; more often old and new co-exist because the old serves some purposes better than the new).

print for deep reading and screens for everything else.[338] It is a strategy that will also help students develop better media literacy through an understanding of different forms and the advantages and disadvantages of each.

E. "That's Not Writing, That's Typing"[339]

Like reading technologies, the only issue here is whether to encourage the use of laptops or pen and paper for note-taking and other writing tasks. Common sense says students cannot write as fast as they type, so having them take notes by hand forces them to slow down and become more selective in what they record.[340] In theory this should help students focus on better understanding the material because out of necessity they will need to summarize it in their own words. One learning expert takes this to the extreme by forbidding students in his class from taking any notes at all in the belief that they will learn more by devoting their full attention to the discussion rather than splitting it between listening and writing.[341]

The prevailing assumption about students using laptops to take class notes is that they mindlessly type away trying to capture the teacher's every word.[342] Thus, they listen for accuracy like a stenographer instead of understanding. On the other hand, perhaps laptop-savvy students take better quality notes than we think. And if they prefer to use a laptop, who are we to judge?

Research on note-taking styles is still emerging and, therefore, limited, but so far it supports the view that taking notes by hand improves learning compared to using a laptop.[343]

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338 *See* BARON, *supra* note 274, at 222–28.

339 *See* Ewin Ritchie Elmont, *What Capote Said About Kerouac*, N.Y. TIMES (Oct. 25, 1992), http://www.nytimes.com/1992/10/25/nyregion/l-what-capote-said-about-kerouac-670892.html [http://perma.cc/288E-EY9B] (quoting Truman Capote).

340 *See* Mangen & Velay, *supra* note 302, at 389; Toft, *supra* note 302.

341 *See* Glenn, *supra* note 109.

342 *See* Pam A. Mueller & Daniel M. Oppenheimer, *The Pen Is Mightier than the Keyboard: Advantages of Longhand over Laptop Note Taking,* 25 PSYCHOL. SCI. 1159, 1160 (2014) (noting that studies show most students type significantly faster than they write suggesting laptop use facilitates a transcription-like note-taking style); *cf.* Keim, *supra* note 224, at 59 (stating that the text manipulation powers of a word processor could aid complex thought and its speed might feel to some more true to the mind than writing by hand).

343 *See* Mangen & Velay, *supra* note 313, at 76 (summarizing studies involving children that compare typing to writing while acknowledging that research is still sparse); Mueller & Oppenheimer, *supra* note 342, at 1166; Hannah Seehafer, *Effects of Learning Style on Paper Versus Computer Based Reading Comprehension*, RED RIVER PSYCHOL. J. 1, 5–6 (2014), http://www.mnstate.edu/uploadedFiles/Internal/Content/Academics/Psychology/Red_River_Psychology_Journal/HSeehafer2014.1.pdf [http://perma.cc/4DCY-ZE3Y] (college students had higher test scores when they read and wrote answers on paper compared to computers); Timothy J. Smoker et al., *Comparing Memory for Handwriting Versus*

As a preliminary matter, researchers have found that note-taking style correlates with academic success.[344] Among all students using laptops, those who transcribe class discussion do more poorly on tests measuring conceptual understanding than those employing a more selective note-taking style.[345] Research also shows that the majority of laptop users default to the less effective transcribing style even *after* the teacher warns them against it and explains why.[346] Thus, even when students use laptops for their intended purpose rather than to multitask, they have a deleterious effect on learning by encouraging a counterproductive note-taking style.[347]

By comparison, studies show that the physical act of writing things down, like making "to do" lists, enhances memory.[348] Another study found students who take notes by hand had better comprehension and recall than laptop users.[349] Even when both

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Typing, PROC. HUM. FACTORS & ERGONOMICS SOC'Y, ANN. MEETING, Oct. 2009, at 1744, 1746, http://teacherinquiryboard.weebly.com/uploads/2/6/4/1/26418271/comparing_memory_for_handwriting_versus_typing.pdf [http://perma.cc/2J5G-69U2] (recall and recognition of words were better for those writing by hand compared to typing); Tiffany O'Callaghan, *The Writings on the Screen*, NEW SCIENTIST, at 43 (Nov. 1, 2014), http://www.newscientist.com/article/mg22429930.500-goodbye-paper-what-we-miss-when-we-read-on-screen.html (separate studies have found learning is enhanced in both young children and adults when we write things down by hand because doing so recruits brain circuits devoted to physical movement which seems to enhance memory).

To date, I have found only one study comparing the cognitive effects of note-taking on a tablet to taking them by hand. *See* Anne Mangen et al., *Handwriting Versus Keyboard Writing: Effect on Word Recall*, J. WRITING RES. 299, 299, 312 (2015) [hereinafter Mangen et al., *Handwriting Versus Keyboard Writing*] (containing a study comparing word recall and recognition between college students writing words down by hand, typing them on a laptop, and using a tablet that partly replicated Smoker's study, *supra,* by finding that handwriting improved recall though no differences were found in word recognition).

344 *See* Matthew E. Barrett et al., *Technology in Note Taking and Assessment: The Effects of Congruence on Student Performance*, INT'L J. INSTRUCTION, Jan. 2014, at 51, 52 (discussing relationship between note-taking style and learning); Wei et al., *supra* note 248, at 148, 153 (articles cited therein); Toft, *supra* note 302.

345 *See* Mueller & Oppenheimer, *supra* note 342, at 1162, 1166 (verbatim note-taking style correlates with shallow understanding).

346 *Id.* at 1162–63, 1167.

347 *Id.* at 1166.

348 *See* BARON, *supra* note 274, at 143; Smoker et al., *supra* note 343, at 1744; Anna Mikulak, *Getting It in Writing*, OBSERVER, Sept. 2014, http://www.psychologicalscience.org/index.php/publications/observer/2014/september-14/getting-it-in-writing.html [http://perma.cc/6NGD-DY8Q]; O'Callaghan, *supra* note 343, at 43; Toft, *supra* note 302.

349 Mueller & Oppenheimer, *supra* note 342, at 1166 (stating that researchers found students taking notes by hand have better recall of facts than laptop users when there is a delay between the lesson and follow-up testing, but no difference when testing is done immediately afterwards); *see* Aguilar-Roca et al., *supra* note 246, at 1304 (finding that students who took notes by hand had a "significantly" higher number of "As" than laptop users); Mangen et al., *Handwriting Versus Keyboard Writing, supra* note 343, at 312; Subrahmanyam et al., *supra* note 313, at 21–22 (finding that students at a large California university who took notes by hand produced better written reports that

groups reviewed their notes a week later before a follow-up test, students who took notes by hand had better conceptual understanding and even superior factual recall compared to those who took "verbatim"-style notes on their laptops.[350] In yet another study, college students taking notes by hand did "significantly" better on a final exam, including earning more As, than those using laptops.[351] The researchers found this particularly surprising since the SAT scores of the laptop users predicted they would outperform the other group.[352]

The explanation for all these results is much the same as those used to explain the cognitive advantages of print over e-text.[353] Just like books, writing by hand is a multimodal learning experience that engages brain circuitry devoted to both visual and physical processing.[354] Typing also has multimodal characteristics, but writing takes greater eye-hand coordination since students must, in effect, draw the shape of each letter.[355] And because writing requires greater focus and concentration

reflected superior critical thinking skills compared to laptops users when working under "real world" conditions); O'Callaghan, *supra* note 343, at 43; Toft, *supra* note 302 (adults who took notes by hand and were then tested on the material several weeks later had better scores than the laptop users).

350 Mueller & Oppenheimer, *supra* note 342, at 1166 (finding no difference between groups with respect to factual recall when test administered right after the lesson). The Mueller and Oppenheimer study compiles the results of three independent studies the researchers conducted at Princeton and UCLA. *Id.*; *see also* SARA C. BROADERS & MICHAEL SMUTKO, INTERNET USAGE DURING CLASS ASSOCIATED WITH LOWER COURSE GRADES (2015), http://www.weinberg.northwestern.edu/discover/news/2015/documents/electronic-devices-impact-classroom-broaders-smutko.pdf [http://perma.cc/ZN34-U57W] [hereinafter BROADERS & SMUTKO, INTERNET USAGE DURING CLASS] (noting a study by Northwestern researchers which finds college students taking notes by hand obtain the highest grades); Sara C. Broaders & Michael Smutko, *Internet Use Decreases Student Lecture Comprehension,* poster for *25th Annual Convention*, ASS'N POL. SCI. (May 25, 2013), http://aps.psychologicalscience.org/convention/program_2013/search/viewProgram.cfm?Abstract_ID=28978&AbType=&AbAuthor=&Subject_ID=&Day_ID=all&keyword [http://perma.cc/52WA-WRZ9] [hereinafter Broaders & Smutko, *Internet Use Decreases Comprehension*] (showing a poster presentation reporting results of research that found students taking notes by hand had better test scores).

351 Aguilar-Roca et al., *supra* note 246, at 1304 (finding, however, no difference in the number of F's between the groups); *see* BROADERS & SMUTKO, INTERNET USAGE DURING CLASS, *supra* note 350; *see also* Broaders & Smutko, *Internet Use Decreases Comprehension*, *supra* note 350; Subrahmanyam et al., *supra* note 313, at 21–22 (stating that college students taking notes by hand wrote better reports).

352 Aguilar-Roca et al., *supra* note 246, at 1304, 1306.

353 *See* BARON, *supra* note 274, at 142–43 (stating that writing is a tactile, or haptic, experience); Mangen & Velay, *supra* note 313, at 75; Mangen & Velay, *supra* note 302; Tanner, *supra* note 307, at 9 (taking notes by hand is the cognitive equivalent of reading a book, while typing is the equivalent of reading a screen).

354 Mangen & Velay, *supra* note 302*,* at 389; Keim, *supra* note 224, at 56–57 (the linkage between body and mind when we write by hand is intimate and profound—hands help us see); Mikulak, *supra* note 348; Toft, *supra* note 302.

355 Mangen & Velay, *supra* note 302, at 385–86, 389.

than typing, it may even promote more precision in the expression of thought in addition to deeper engagement.[356] The greater physicality of writing appears to promote linkages in the brain between visual, tactile, motor, and spatial neural circuits, which means it is processed differently than typing in ways that seem to enhance recall and comprehension.[357]

While typing is a physical act too, some aspects of it are decoupled from the visual part, making it a "radically" different cognitive experience than writing by hand.[358] Even the visual aspects of writing by hand require more engagement and concentration than typing which eventually becomes so automated that students can do it without even looking at the keypad or screen.[359] As with print, pen and paper also promote deeper engagement, and thus better learning, because the medium lacks the interferences and distractions associated with wireless devices.[360]

That taking notes by hand has demonstrable advantages over typing them on a laptop has been suggested as reason enough to ban laptops.[361] But if the teacher is making good use of them in class, to the extent student notes suffer it may still be an acceptable trade-off. If the professor is not making active use of laptops during class, they should be closed anyway which is a great opportunity to talk with students about the advantages of adopting a hybrid note-taking and drafting style. Share with students the research discussed here that taking notes by hand

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356 Writing by hand is like "thinking with a pencil." Mangen & Velay, *supra* note 313, at 75 (noting that draftsmen practiced in the use of CAD software still draw preliminary sketches by hand because it is "thinking with a pencil"); *see also* WILSON, *supra* note 224, at 158 (writing and drawing are strongly related to other skills requiring precision); WOLF, *supra* note 5, at 65–66 (stating that the process of writing changes our thoughts and helps us express them with more precision); Keim, *supra* note 224, at 56 (citing an educational psychologist who notes that we use our hands to access our thoughts).

357 *See* BARON, *supra* note 274, at 143; Wei et al., *supra* note 248, at 148–49; Mangen & Velay, *supra* note 302, at 389–90. Experts also believe an advantage of writing by hand is that it engages spatial circuitry in the brain which encodes the location of words and paragraphs on the page, providing a structure and organization for our thoughts that is lacking when we type on a screen. Keim, *supra* note 224, at 59.

358 *See* Mangen & Velay, *supra* note 302, at 389–90; Keim, *supra* note 224, at 56 ("What our hands do with a keyboard is very different than with pen and paper."); Toft, *supra* note 302.

359 *See* Mangen & Velay, *supra* note 302, at 389–90, 395; Keim, *supra* note 224, at 56 (stating that a central property of handwriting is that it unifies hand, eye, and attention at a single place and time in the brain).

360 *See* POWERS, *supra* note 5, at 216; Wei et al., *supra* note 248, at 148, 155 (finding that students using laptops to take notes while multitasking had poor quality class notes and weaker recall of the material).

361 Steven Eisenstat, *A Game Changer: Assessing the Impact of the Princeton/UCLA Laptop Study on the Debate of Whether to Ban Law Student Use of Laptops During Class*, 92 U. DET. MERCY L. REV. 83 (2015).

can improve memory and comprehension, which is why even Silicon Valley technophiles prefer pen and paper to note-taking apps.[362] It is consistent as well with surveys of college students that show some still prefer a pen and paper to the keyboard for the same reasons.[363] When it comes to drafting, encourage students to experiment with each writing technology while reflecting on how it affects the writing process.[364] As a metacognitive exercise, some students may discover they do their best work composing on a keyboard while editing with a pen and paper insofar as it helps them better visualize how all the pieces fit together. Others may find that outlining by hand sharpens their analysis and organization in ways that a keyboard does not.[365] As with reading technologies, the key thing is to put aside clichés about how "digital natives" learn best and instead help students understand the importance of choosing the right tool for the job based on what works best for them and its compatibility with the particular objective at hand.

As a practice skill, there are times when lawyers need to put away technology and pick up a pen and pad of paper instead.[366] In depositions, interviews, and similar situations lawyers must be fully present to observe and record their impressions of the

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362 *See* LEVITIN, *supra* note 113, at 67–68 (stating that a large number of successful professionals, including techies, still prefer pen and paper for some purposes); Lee Gomes, *Why Computers Can't Kill Post-Its,* FORBES (Jan. 22, 2009), http://www.forbes.com/2009/01/21/postits-digital-tools-tech-intel-cz_lg_0122postits.html [http://perma.cc/9HGL-XPXD] (MIT study found "Post-Its" are near perfect data storage tool that techies love because it is more efficient than note-taking apps by leveraging the brain's ability to remember information based on spatial and physical properties); *see also* POWERS, *supra* note 5, at 216 (pen and paper are arguably more useful today because they give us what we desperately need—disconnectedness).

363 *See* Ragan et al., *supra* note 245, at 81 (containing a survey of university students enrolled in a large lecture class that found many preferred to take notes by hand); Julie Berkovatz & Erica de Guzman, *The Evolution of Note Taking: A Study on Traditional Hard Copy Methods vs the Emerging Soft Copy Method,* SJSU SCHOLAR WORKS, Oct. 24, 2011, at 3–5 (citing a student-authored study finding a majority of college students surveyed preferred handwritten notes to the computer); Subrahmanyam et al., *supra* note 313, at 20–21 (containing a survey of college students which finds they prefer note-taking by hand).

364 *See generally* Helen A. Soter, *Learning How to Learn: Incorporating Metacognition in the Business Writing Classroom*, *in* STUDENT SUCCESS IN WRITING CONF. (Apr. 17, 2015), http://digitalcommons.georgiasouthern.edu/cgi/viewcontent.cgi?article=1077&context=sswc [http://perma.cc/8ZHW-TKJH].

365 Some students may find the best advantage to shutting off technology in favor of a pen and paper is that it creates a distraction-free work environment, which can improve the quality of their work for that reason alone. *See* BARON, *supra* note 274, at 164 (discussing the practice of successful writers who shut off technology when they work).

366 *See* Sam Glover, *Lawyers Should Take Notes by Hand*, LAWYERIST (June 17, 2014), https://lawyerist.com/74436/lawyers-take-notes-hand/ [https://perma.cc/D2WX-A7U9] (giving several reasons why lawyers should take notes by hand including promoting active listening skills when meeting with clients).

others in the room. In other contexts, like meetings with clients and partners, putting away technology in favor of pen and paper communicates engagement, rapport, and warmth.[367] The caveman brain was designed to excel at these so-called "soft skills" which, ironically, may become increasingly important as they may be one of the few legal practice skills that remains beyond the reach of the lawyer-bots.[368] Encouraging students to develop a hybrid note-taking style, therefore, promotes not only better learning and media literacy, but also gives students a chance to practice some other essential lawyering skills.

F. "Survey Says!": Meta-Analyses of Digital Teaching Tools

Two recently published meta-studies are among the largest to date assessing the overall effectiveness of digital teaching technologies.[369] They did so by examining the impact of these tools on student learning outcomes in a variety of classroom contexts from kindergarten to post-graduate training.[370]. Though neither study focused on specific classroom tools like laptops, they are still valuable insofar as having distilled data from thousands of independent studies into some general principles and guidelines that we can use to help inform our own decisions about how best to use technology in the law school classroom.

The first of these studies is a meta-analysis commissioned by the U.S. Department of Education ("DOE Study") in 2010 that reviewed more than 1100 independent studies conducted between 1996 and 2008 for reliable data on the effectiveness of online instructional tools.[371] The second study was published in 2012 by Durham University in the U.K. ("Durham Study") involving an analysis of forty-eight separate meta-studies from

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367 *See id.*; Travis Bradberry, *The Real Harm in Multitasking,* INC. (Jan. 6, 2015), http://www.inc.com/travis-bradberry/the-real-harm-in-multitasking.html [http://perma.cc/B6T9-LUQ6] (multitasking during business meetings shows low emotional intelligence skills which is sure to undermine career success).

368 *See supra* note 12.

369 *See* DURHAM STUDY, *supra* note 228; U.S. DEP'T OF EDU., EVALUATION OF EVIDENCE-BASED PRACTICES IN ONLINE LEARNING: A META-ANALYSIS AND REVIEW OF ONLINE LEARNING STUDIES (2010), https://www2.ed.gov/rschstat/eval/tech/evidence-based-practices/finalreport.pdf [https://perma.cc/XL9F-KYUS] [hereinafter DOE STUDY].

370 *See* DOE STUDY, *supra* note 369, at xii–xiii (noting that although the purpose of study was to determine the effectiveness of online education for K–12 students, the majority of data analyzed involved community college, college, and grad students); DURHAM STUDY, *supra* note 228, at 5 (involving an analysis of forty-eight independent meta-analyses that examined the effectiveness of classroom technology on five- to eighteen-year-old students).

371 DOE STUDY, *supra* note 369, at 11–14 (stating that the meta-analysis eliminated all but forty-five out of the 1132 studies it began with due to methodological issues).

around the globe that examined the general effectiveness of digital classroom tools in K–12 schools.[372]

In sum, the DOE Study found that online tools work best when combined with face-to-face classroom teaching as part of a hybrid approach to instruction.[373] To the extent any correlation was found between the use of technology and better learning outcomes, the study's authors cautioned against attributing it to the technology itself rather than the extra hours of instruction students received in the blended programs.[374] The Durham Study reached a similar conclusion with respect to digital classroom tools finding that they generally work best when supplementing existing teaching practices rather than replacing them.[375] The authors of the Durham Study also cautioned against assuming a causal connection between classroom technology and better learning outcomes because of methodological problems with the underlying studies.[376] Consequently, both meta-studies came to the unremarkable conclusion that although technology may help, it is ultimately the teacher using it that matters most to student success.[377]

Nonetheless, the authors of each study identified a few teaching practices they found to be especially effective. For instance, the DOE Study concluded that instructor-led and collaborative online learning opportunities often worked better than independent, self-directed ones.[378] Technologies that let students control the pace of their own learning like podcasts also worked well, as did ones that encouraged students to monitor their learning.[379] The authors of the Durham Study found the use of digital technologies that promote collaborative learning among small groups of students are effective along with tools that extend learning opportunities outside classroom walls like video simulations.[380]

While none of these conclusions are especially earth-shattering given what we already know about good pedagogy, they tend to confirm the work of educational

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372 DURHAM STUDY, *supra* note 228, at 5, 10–11.

373 DOE STUDY, *supra* note 369, at xviii.

374 *Id.*

375 *See* DURHAM STUDY, *supra* note 228, at 4–5 (noting that the authors of the meta-study observed a lack of controls in the underlying independent research studies regarding teacher quality, instructional methods, curriculum, etc., which compromised the validity of the results).

376 *Id.* at 3.

377 *Id.*; *see also* DOE STUDY, *supra* note 369, at 52.

378 DOE STUDY, *supra* note 369, at xv.

379 *Id.* at xvi.

380 DURHAM STUDY, *supra* note 228, at 3–5.

technology historians like Professor Cuban by finding that digital technologies are most effective when combined with established teaching practices as part of a hybrid approach to classroom instruction.[381]

CONCLUSION

The term "digital native" is misleading because it suggests a sharp divide between today's law students and their predecessors. It encourages inaccurate stereotypes and clichés that can have a detrimental effect on their legal education. The erroneous belief that all students are tech savvy, for instance, means we may mistakenly jump to the conclusion that it is unnecessary to provide training in basic technology skills. The assumption that multitasking is part of a new "learning style" means we may neglect to teach students the important mental discipline needed to single-task.

This Article argues that classroom practices informed by an understanding of how the brain learns will always be more successful than approaches based on observations about students' changing technology habits. Technology and forms of media are always changing, but the fundamentals of teaching students to be good critical thinkers have not changed much at all over time. Whether writing an appellate brief, synthesizing a line of cases, or solving a complex problem for a client, it will always demand an ability to shut out distractions and focus deeply on that task at hand.

Of course we need to prepare students to work in a digital environment. But teaching them how to use the latest law practice app will never get them a job—anyone can learn to do that. Teaching them, instead, to be good thinkers is the gift that keeps on giving. To maximize our effectiveness as teachers, history and learning science both tell us that the most successful strategy is a hybrid approach that combines the best of established classroom practices with new technologies that fill a niche better than existing options.

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381 *See* DOE STUDY, *supra* note 369, at xi–xvi; DURHAM STUDY, *supra* note 228, at 3–5; *supra* p. 253 and notes 57–60; *supra* pp. 277–78 and notes 230–33.