ARTICLE

LEGAL EDUCATION IN THE AGE OF COGNITIVE SCIENCE AND ADVANCED CLASSROOM TECHNOLOGY

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Cognitive scientists have made major advances in mapping the process of learning, but legal educators know little about this work. Similarly, law professors have engaged only modestly with new learning technologies like PowerPoint, classroom response systems, podcasts, and web-based instruction. This article addresses these gaps by examining recent research in cognitive science, demonstrating how those insights apply to a sample technology (PowerPoint), and exploring the broader implications of both cognitive science and new classroom technologies for legal education. The article focuses on three fields of cognitive science inquiry: the importance of right brain learning, the limits of working memory, and the role of immediacy in education. Those three areas are fundamental to understanding both the effective use of new classroom technologies and the constraints of more traditional teaching methods.

I. INTRODUCTION

Educators have a long history of resisting change. When the printing press debuted in the fifteenth century, one scholar famously declared that "the world has got along perfectly well for six thousand years without printing, and has no need to change now."[1] His colleagues at medieval universities vehemently opposed mechanical printing, fearing that it would degrade scholarship, destroy monastic education, and replace rigorous academic tutelage with independent inquiry.[2] Four centuries later, introduction of the chalkboard caused a similar outcry: Nineteenth century teachers doubted that this newfangled invention could improve their teaching in any way.[3]

Today, printed books and chalkboards are the traditional learning tools that faculty members vigorously defend. Electronic sources, internet courses, podcasts, and Microsoft PowerPoint are the suspect newcomers. Most professors did not use these tools as students, and the new technologies challenge established teaching routines. Some faculty accuse new learning methods of "dumbing down" education: they dismiss PowerPoint slides and iPod tracks as pandering to a generation raised on television, high-speed cable, and the internet.

Among legal educators, such resistance to new educational tools is particularly troublesome. Lawyers are thinkers and communicators; law

[1] *See* DIANA C. OBLINGER & ANNE-LEE VERVILLE, WHAT BUSINESS WANTS FROM HIGHER EDUCATION 53 (1998) (quoting Fra Filippo di Strata).

[2] Bernard J. Hibbets, *Yesterday Once More: Skeptics, Scribes, and the Demise of Law Reviews,* 30 AKRON L. REV. 267, 268-72 (1996).

[3] JACQUELINE HANSEN, *Training Techno-riffic Teachers, in* INTEGRATING TECHNOLOGY IN HIGHER EDUCATION 273, 274-75 (M.O. Thirunarayanan & Aixa Pérez-Prado eds., 2005) [hereinafter *INTEGRATING TECHNOLOGY*].

students will succeed in the new, highly competitive global economy only if they analyze and articulate ideas better than other professionals worldwide. Communication and information technologies are not just instruments of learning in law school; they are the tools of the lawyer's trade. If law faculties neglect to master new forms of gathering, organizing, and disseminating information, they risk failing students both in the classroom and after graduation.

Academic opposition to technological innovation, moreover, is emblematic of resistance to other forms of educational change. Despite significant advances in the science of learning, law professors today teach much as their own professors did a generation ago. Legal scholars and lawyers know surprisingly little about the cognitive science research that has unveiled new methods of harnessing the brain to work harder and smarter. The legal profession depends upon rigorous thinking, creative problem solving, and persuasive advocacy for success. Yet, law faculties have remained strangely oblivious to research about how the brain works.

This Article addresses both the gap in law faculties' comprehension of cognitive processes and their reluctance to embrace new classroom technologies; the two omissions are related. The article first examines three basic discoveries about human learning: the synergy of right and left brain thinking, the constraints on working memory, and the importance of personal interactions between teacher and students. Many other cognitive science insights could inform legal education, but these three are fundamental. The first Part of the Article thus outlines recent research in each of these essential areas.

To illuminate these principles further, while encouraging faculty to overcome their discomfort with new teaching technologies, I then apply these cognitive science insights to a recent classroom innovation, PowerPoint. Drawing on the cognitive science research, I offer ten guidelines for improving PowerPoint use in the law school classroom. These guidelines serve two complementary purposes: on a practical level they can help professors adopt a new technology and use it more effectively, while on a more theoretical plane the guidelines illustrate how educators can apply basic learning theory to classroom practices.

In the final Part of the Article, I return to the larger question of how cognitive science and technology can work together to improve legal education. To succeed as educators, practitioners, and professionals, law faculty must cultivate a much deeper understanding of how the brain works. In addition to applying that knowledge to teaching law, faculty should share those insights with law students, helping them manage their own intellectual resources and develop new capabilities for practice. Implementing new learning technologies in law school is essential both for training students and for helping us understand the subtle workings of the brain. New technologies prompt us to reflect on our capabilities while also enhancing them.

II. BRAIN BASICS: THREE PRINCIPLES OF LEARNING

Cognitive science research in classrooms, laboratories, and neuro-imaging centers has yielded profound insights into how humans learn. Some of these findings support long-held notions, but many contradict our most cherished assumptions and practices. Investigators have uncovered promising new approaches for enhancing comprehension, critical thinking, and communication among professionals. This Part explores three areas of recent inquiry: research on the division between the brain's left and right hemispheres, investigations into cognitive load, and explorations of the beneficial effect of human interaction on learning. All three of these fields hold key perspectives for legal education.[4]

A. The Brain's Two Hemispheres

The brain's two halves emphasize different tasks. Although individuals vary in how these hemispheres function, the left brain generally focuses on linear, sequential ideas, while the right brain concentrates on patterns and connections. The left brain, for example, helps an individual predict the next symbol in a series of letters or numbers.[5] The right brain enables that person to quickly choose two identical graphic designs out of a larger collection.[6] The left brain analyzes the pieces, while the right brain synthesizes the big picture.[7]

In learning, these two processes complement one another. The left brain grabs bits of potentially useful data from the environment, while the right brain relates them to one another. The left brain captures "text," whether composed of words, numbers, or other isolated pieces of information, while the right

[4] Most studies of adult cognition use non-law materials for testing, but the findings transfer readily to law. The brain does not distinguish among subject areas in its cognitive functions. Most of the studies cited in this Article, moreover, examined mastery of complex scientific or engineering concepts that are surprisingly analogous to legal principles. In particular, learning these principles required subjects to do more than simply recite formulas from memory; they had to learn to apply the concepts in new contexts, much as law faculty teach law students to apply legal principles to new controversies.

[5] *See* ROBERT ORNSTEIN, THE RIGHT MIND 8 (1997).

[6] *Id.*

[7] Although scientists widely recognize this division of labor, they also note that the distinction between "left" and "right" brains is not quite this simple. Individuals vary in their allocation of the tasks between hemispheres, and those hemispheres almost always work together to achieve integrated results. Cognitive scientists, however, find the distinction useful as a way of describing the brain's different, but related, systems. *See generally* ORNSTEIN, *supra* note 5, at 81. Educators similarly recognize that "[t]he 'two brain' doctrine is most valuable as a metaphor that helps educators acknowledge two separate but simultaneous tendencies in the brain for organizing information." RENATE NUMMELA CAINE & GEOFFREY CAINE, MAKING CONNECTIONS: TEACHING AND THE HUMAN BRAIN 91 (1994). The fact that the brain may house functions in different areas, in other words, is less important than the fact that it encompasses these complementary functions.

brain interprets the context of those data.[8] The best learning draws on both parts of the brain, pursuing both the forest and the trees.

Almost any educational experience, from solo reading to participation in a law school clinic, invokes both the left and right hemispheres. The majority of academic programs, however, focus more heavily on linear thinking and data transmission—both left brain processes—than on context and synthesis, the right brain's specialties.[9] Experts in higher education have started to recognize the costs of this left brain dominance, calling for increased classroom attention to right brain training. Right brain thinking is essential for integrating concepts, perceiving connections among facts, and other sophisticated forms of analysis.[10]

As part of its penchant for synthesizing information, the right brain has a special ability to draw meaning from pictures and diagrams. This aptitude can expand learning; graphic elements often portray relationships and context more efficiently than text does. The right brain's capacity to interpret context and patterns, particularly through visual elements, complements the left brain's focus on words and discrete pieces of data. As a result, most "[p]eople learn more deeply from words and pictures than from words alone."[11] And,

[8] ORNSTEIN, *supra* note 5, at 101-13.

[9] *See id.* at 171-72. *See also* LESLIE A. HART, HUMAN BRAIN AND HUMAN LEARNING (Karen D. Olsen ed., Books for Educators updated ed. 1998) (1983) (avoiding left brain-right brain distinctions, but criticizing the overemphasis of sequential, "logical" thought in schools).

[10] DANIEL H. PINK, A WHOLE NEW MIND (2005); Richard E. Mayer, *Cognitive Theory and the Design of Multimedia Instruction: An Example of the Two-Way Street Between Cognition and Instruction, in* APPLYING THE SCIENCE OF LEARNING TO UNIVERSITY TEACHING AND BEYOND 55 (Diane F. Halpern & Milton D. Hakel eds., 2002). For a particularly interesting discussion of right/left brain theory in law, together with a call to increase right brain thinking, *see* Jack A. Hiller & Bernhard Grossfeld, *Comparative Legal Semiotics and the Divided Brain: Are We Producing Half-Brained Lawyers?,* 50 AM. J. COMP. L. 175 (2002).

[11] Richard E. Mayer, *Cognitive Theory of Multimedia Learning, in* THE CAMBRIDGE HANDBOOK OF MULTIMEDIA LEARNING 31, 31 (Richard E. Mayer ed., 2005) [hereinafter CAMBRIDGE HANDBOOK]. *See also* Ruth Colvin Clark & Richard E. Mayer, *Using Rich Media Wisely, in* TRENDS AND ISSUES IN INSTRUCTIONAL DESIGN AND TECHNOLOGY 311, 315 (2d ed. 2007) (citing studies); Roxana Moreno & Alfred Valdez, *Cognitive Load and Learning Effects of Having Students Organize Pictures and Words in Multimedia Environments: The Role of Student Interactivity and Feedback,* 53 EDUC. TECH. RES. & DEV. 35 (2005); Michael Macaulay, *Embedding Computer-Based Learning with Learning Aids: A Preliminary Study,* 29 INT'L J. INSTRUCTIONAL MEDIA 305, 307-08 (2002) (reviewing studies); David S. Wallace et al., *The Effect of Knowledge Maps that Incorporate Gestalt Principles on Learning,* 67 J. EXPERIMENTAL EDUC. 5 (Fall 1998) (students learned the process by which bills become laws more readily when studying well constructed diagrams than when reading text).

In one representative study, students learned how lightning is formed by studying slides with pictures, slides with text, or slides with both pictures and text. Students who viewed

although we associate pictures with elementary education, graphics are even *more* essential learning aids for advanced students mastering complex concepts.[12]

In addition to helping students learn difficult material, graphics can boost long-term memory and recollection. The brain stores words and images separately, offering two independent avenues for recollection. These enriched memory stores increase most learners' access to material.[13] Thus, harnessing the right brain, by encouraging it to work in tandem with the left, can significantly increase learning.

The right brain-left brain distinction holds a key insight for law school teaching. Legal study requires the type of integrative thinking that the right brain controls. Although law students must absorb prodigious amounts of data, they must also relate those pieces to the whole, synthesize principles, and apply concepts to new problems. As the amount of material transmitted in legal classrooms has expanded over the last three decades, requiring increased left brain focus, faculty may have drifted further than realized from right brain training.[14] One of the challenges facing legal education today is to find new ways of reviving right brain emphasis in law school.

B. Cognitive Load

Like a desktop computer, the brain contains two types of memory: long-term memory and working memory.[15] Long-term memory, which holds all of

both pictures and text performed significantly better than other students on recall and problem solving tests. Moreno & Valdez, *supra,* at 39-40.

[12] *See, e.g.,* Michael Macaulay & Ioanna Pantazi, *Material Difficulty and the Effectiveness of Multimedia in Learning,* 33 INT'L J. INSTRUCTIONAL MEDIA 187, 191-92 (2006) (multimedia presentation significantly improved student scores when studying very difficult material, but had no significant effect on learning of easier material).

[13] Stephen K. Reed, *Cognitive Architectures for Multimedia Learning,* 41 EDUC. PSYCHOLOGIST 87, 88 (2006).

[14] Increased content in legal education stems from numerous sources. The law itself has grown, embracing fields like ERISA, employment law, and environmental law that barely existed before 1975. Within traditional subjects, the number of cases, statutes, and novel problems has also grown exponentially. Law schools' beneficial attempt to integrate the perspective of other disciplines has compounded the problem; until a student masters the basics of these fields, the interdisciplinary perspective is yet another fact to be learned. Globalization, finally, has markedly expanded the law school curriculum, requiring students to gain some familiarity with both international organizations and foreign legal approaches. The combination of these trends has created an unmanageable amount of information that most professors attempt to transmit—and their students to absorb—in the law school classroom. Our desperate attempts to keep up with the sheer amount of law may have affected our traditional role of teaching students to "think like lawyers" more than we realize.

[15] *See* JOHN J. RATEY, A USER'S GUIDE TO THE BRAIN 131 (Pantheon Books 2001). Although the computer analogy is useful to explain the brain's two types of memory,

our recollections and accumulated knowledge, is vast. Grand chess masters, for example, can store in long-term memory up to 100,000 different board configurations—in addition to their friends' names, childhood memories, and everything else of importance to them.[16] Experts in other fields master equivalent amounts of data. If properly prompted, the brain's long-term memory can store immense amounts of educational data.

Working memory, on the other hand, is disappointingly small. Most people can hold only about seven pieces of information simultaneously in working memory.[17] Short-term memory, moreover, can actively manipulate only two to four bits of information at the same time.[18] This human equivalent of the computer's RAM retains input for only twenty seconds.[19] Remembering material for longer periods requires constant rehearsal; this is why we mutter a new phone number to ourselves while searching for a pen to record it.

Working memory, in sum, is a narrow channel that tolerates a very low cognitive load. Yet all new information must navigate this passage to reach the brain's long-term storehouse. Working memory, therefore, is the bottleneck that constrains learning. As one psychologist warns, "instruction requiring learners to deal with novel information must be processed by a structure that is minute in capacity and that retains the new information for no more than a few seconds."[20] Law professors rarely contemplate the constraints posed by working memory, but these limits are part of the brain's inherent structure; few students can process more than four pieces of information simultaneously. To maximize learning of any kind, educators must work carefully within working memory's cognitive load.

There are at least three ways for instructors to reduce cognitive load, thereby amplifying opportunities for their messages to reach the brain. First, when conveying complex information, it is critical to reduce distractions. Speakers sometimes attempt to excite an audience's interest by telling jokes, relating anecdotes, or offering other tangential information. These embellishments

cognitive scientists stress that the human brain differs greatly from computers in other ways. Popular presentations often mischaracterize the brain as computer-like. *Id.* at 5.

[16] JOHN SWELLER, *Implications of Cognitive Load Theory for Multimedia Learning, in* CAMBRIDGE HANDBOOK, *supra* note 11, at 19, 20.

[17] *Id.* at 21. The upper limit varies somewhat by individual and type of data, but rarely exceeds nine. For the classic paper in this field, see George A. Miller, *The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information,* 63 PSYCHOL. REV. 81 (1956).

[18] Sweller, *supra* note 16, at 21. *See also* Nelson Cowan, *The Magical Number 4 in Short-Term Memory: A Reconsideration of Mental Storage Capacity,* 24 BEHAV. & BRAIN SCI. 87, 88 (2000) (reviewing evidence of the "four bit" theory of working memory). Some psychologists conceptualize the limits on working memory in more complex ways than the four- and seven-bit constraints. *Id.* at 88 (noting seven alternative views). All, however, agree that working memory is very limited.

[19] Sweller, *supra* note 16, at 22.

[20] *Id*.

work all too well: they attract attention, but they absorb working memory's limited resources and squeeze out more important information. Studies, for example, suggest that students are more likely to recall a lecturer's jokes than key content points.[21] Background music, colorful but extraneous videos, and marginally relevant human interest stories can also impair deep learning; students who receive instruction with these interest-inciting "extras" perform more poorly on problem-solving tests than students who receive more straightforward instruction.[22]

This doesn't mean that classrooms must be dry, humorless places. When jokes, anecdotes, videos, and images directly illustrate a concept, they can improve learning.[23] If related to the instructional material, these elements offer new perspectives and engage the brain's right hemisphere.[24] Humor and other tangents may also pace instruction, offering a periodic wake-up call. Because of their very power to command attention, however, it is important to use jokes and other sidelights thoughtfully, invoking them to channel thought toward the primary material rather than away from it.

Second, professors can enhance students' working memory by relating new information to data already stored in long-term memory. Although working memory can accommodate only a few pieces of novel information at a time, its capacity to handle information recalled from long-term memory is much larger.[25] Some researchers suggest this occurs because long-term memory organizes information into schemas; working memory then treats each of these data clusters as a single "chunk" of information that can be examined or manipulated.[26] Under this view, expertise develops as a learner draws new information into working memory, organizes those data into schemas stored in long-term memory, then recalls the schemas to supplement them with still more information. As schemas grow and combine into still larger clusters, working memory can handle increasing amounts of information within its narrow channel. Relating new concepts to ideas that have already been

[21] Walter Kintsch & Elizabeth Bates, *Recognition Memory for Statements from a Classroom Lecture,* 3 J. EXPERIMENTAL PSYCHOL. HUM. LEARNING & MEMORY 150, 151 (1977).

[22] Mayer, *supra* note 11, at 64-65.

[23] *See generally* Diane M. Martin et al., *A Meta-Analytic Assessment of the Effect of Humorous Lectures on Learning,* in CLASSROOM COMMUNICATION AND INSTRUCTIONAL PROCESSES: ADVANCES THROUGH META-ANALYSES 295, 296 (Barbara Mae Gayle et al. eds., 2006).

[24] Most jokes work by invoking the right brain's ability to understand metaphor and connections. The left brain is too literal to understand the humor in most jokes. ORNSTEIN, *supra* note 5, at 97-115. For educational purposes, jokes are similar to graphics and metaphors; they appeal to the right brain.

[25] Sweller, *supra* note 16, at 24.

[26] *Id.* at 24-25; Clark & Mayer, *supra* note 11, at 314; Slava Kalyuga et al., *Managing Split-attention and Redundancy in Multimedia Instruction,* 13 APPLIED COGNITIVE PSYCHOL. 351, 351 (1999).

mastered is a key way to increase working memory's capacity.

Finally, the brain often can expand working memory by drawing upon its separate auditory and visual channels to process information synergistically.[27] If students watch a demonstration or study a diagram while listening to an oral explanation, complementary information reaches working memory through both the auditory and visual channels. This synergy "overclocks" working memory, enabling it to handle somewhat more data than it could through one channel alone.[28] Several controlled experiments confirm that students who study a diagram while listening to an oral explanation learn concepts more readily than students who view the diagram while reading the same description in text.[29] The first format harnesses both auditory and visual channels, while the second attempts to send all information by the visual path alone; for most learners, two avenues allow more efficient processing.

Expanding working memory in this final manner, however, has two important limits. First, to achieve the desired synergistic effect, the information flowing through the auditory and visual channels must be related. Individuals can pursue unrelated tasks through audio and visual channels, but this multitasking simply divides working memory; there is no evidence that it expands the total amount of memory available.[30] The overclocking effect derives from the simultaneous processing of similar information through visual and auditory channels. The simultaneity allows learners to connect the two information stores; connections, in turn, facilitate construction of mental models.[31]

Second, and conversely, *identical* information flowing through the two channels seems to burden working memory rather than enhance it.[32] A group of researchers discovered that students who read an explanation of mechanical engineering concepts while an instructor spoke the same text aloud learned *less* than students who only heard the instructor speak.[33] The impairment may

[27] Clark & Mayer, *supra* note 11, at 315; Richard E. Mayer & Roxana Moreno, *Nine Ways to Reduce Cognitive Load in Multimedia Learning,* 38 EDUC. PSYCHOLOGIST 43, 44 (2003).

[28] Overclocking is the process of speeding up a computer so that it runs faster than the manufacturer intended. Yesterday's teens souped up their cars; today's overclock their computers.

[29] 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) (Experiment One). Interestingly, the difference is particularly large in tests measuring students' ability to apply learning to new problems. *Id.* at 316.

[30] *See, e.g*, Cornelius J. König et al., *Working Memory, Fluid Intelligence, and Attention Are Predictors of Multitasking Performance, but Polychronicity and Extraversion Are Not*, 18 HUM. PERFORMANCE 243 (2005) (success at multitasking correlates significantly with size of working memory).

[31] Mayer & Moreno, *supra* note 29, at 312-14, 318.

[32] Mayer & Moreno, *supra* note 11, at 49.

[33] Slava Kalyuga et al., *When Redundant On-Screen Text in Multimedia Technical*

occur because the brain, distracted by the duplication, devotes part of its working memory to comparing the two streams to monitor whether they remain identical. Small amounts of duplication, such as when a professor displays and reads pieces of statutory text to focus students' attention, probably do not have this effect.[34] But more extensive repetition, such as when a speaker reads at length from bulleted slides, can reduce learning by imposing a separate burden on working memory.[35]

These discoveries about cognitive load offer several additional lessons for legal education. Legal concepts are highly complex; they often require simultaneous attention to the facts of an underlying controversy, the legal procedures employed by parties, and the substantive law governing their dispute. Mastering substantive principles alone can require simultaneous processing of multiple statutory provisions, judicial rulings, and fact patterns. Law school instruction probably exceeds the capacity of students' working memory quite often. The problem is compounded by the fact that professors, who have already combined these elements into larger schema, can accommodate more material in working memory than students can. Cognitive overload may impair student comprehension while remaining invisible to the professor.

Improving legal education requires instructors to focus on the stark limits of working memory. The brain has huge capacities to learn, but new concepts must traverse a peculiarly narrow channel. Professors who understand the constraints of working memory, and who use tools to address those limits, could educate their students more effectively.

C. The Personal Touch

Communication scholars use the term "immediacy" to describe verbal and nonverbal behaviors that humans use to connect with one another while speaking.[36] Immediacy includes eye contact, smiles, gestures, and a large number of other signals that establish a positive bond between a speaker and listener.[37] These social cues powerfully enhance communication in any context, from individual counseling sessions to large group lectures.

Instruction Can Interfere with Learning, 46 HUM. FACTORS 567, 576-78 (2004) (Experiment Three. The students who read the description while listening to it also rated the material as more challenging than the students who simply listened).

[34] *Id*. at 579 (noting different results for redundant presentation of short textual passages).

[35] *Id*. at 580.

[36] *See, e.g.,* Paul L. Witt et al., *A Meta-Analytical Review of the Relationship Between Teacher Immediacy and Student Learning,* 71 COMM. MONOGRAPHS 184, 184-85 (2004) (noting that the eminent scholar Albert Mehrabian coined the term and first explored the concept's implications). *See also* Albert Mehrabian, *Some Referents and Measures of Nonverbal Behavior,* 1 BEHAV. RES. METHODS & INSTRUMENTATION 203 (1969).

[37] *See* Witt et al., *supra* note 36, at 185.

Researchers have determined that professors who display immediacy in the classroom significantly boost their students' interest in a subject.[38] Students engage more enthusiastically with the material when they feel connected to the professor, and their increased motivation may improve learning.[39] Cultivating classroom immediacy, therefore, is an important goal.

Recent studies complement this general principle by demonstrating that students learn more from a humanizing, conversational style than from an overly formal one.[40] Conversational styles use personal pronouns ("I" and "you") rather than purely third-person structures. A conversational tone also addresses the audience directly; acknowledging their learning processes, and offering suggestions. A professor adopting a conversational tone might use phrases like "I know this is a difficult concept," "focus carefully on the bottom portion of the diagram," or "imagine that you represent a client negotiating a long-term supply contract."[41]

Conversational cues like these have a surprising impact on learning, especially on the deepest forms of learning that allow listeners to apply information to new situations. Ten controlled studies have each identified a strong positive relationship between deep learning and instruction delivered in a conversational style; students who hear information presented in an informal, personal style perform significantly better on problem-solving tests than students who hear the same information presented in a more formal manner.[42] Even just substituting the pronoun "your" for "the" significantly increases learning.[43]

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[38] *Id.* at 199 (using meta-analysis to find a significant correlation between immediacy and affective learning).

[39] *Id.* at 200-01 (studies show only a small immediate relationship between immediacy and cognitive learning, but that the long-term, indirect relationships may be greater). *See, e.g.,* Mike Allen et al., *The Role of Teacher Immediacy as a Motivational Factor in Student Learning: Using Meta-Analysis to Test a Causal Model,* 55 COMM. EDUC. 21, 26 (2006).

[40] Richard E. Mayer, *Principles of Multimedia Learning Based on Social Cues: Personalization, Voice, and Image Principles,* in CAMBRIDGE HANDBOOK, *supra* note 11, at 201.

[41] *Id.* at 203-04.

[42] *Id.* at 206. Each of these ten studies measured learning through problem solving "transfer" tests, which require students to apply their learning to new situations. These tests tap deeper levels of understanding than recall or memory tests.

[43] Richard E. Mayer et al., *A Personalization Effect in Multimedia Learning: Students Learn Better When Words Are in Conversational Style Rather Than Formal Style,* 96 J. EDUC. PSYCHOL. 389 (2004) (discussing three related experiments, where students heard one of two sixty-second descriptions of human respiration. The versions differed only in pronouns; one substituted the word "your" for "the" in twelve places). Further, some students, in other words, heard about "the diaphragm," "the lungs," and "the air sacs," while others heard about "your diaphragm," "your lungs," and "your air sacs." Both groups adequately recalled the basic information, but students who heard the personalized version performed significantly better on a test that required them to apply the information to novel

Psychologists have suggested at least three reasons why personalization may deepen learning. First, encouraging listeners to think of themselves as a reference point may enhance their interest in the subject, which produces more active cognitive processing.[44] Second, personalizing information may help listeners relate new data to existing mental schema; extending mental frameworks in this manner encourages deeper learning.[45] Finally, listeners may respond to the social cues of conversational tone; because another person is addressing them, they feel a "commitment to try to make sense out of what the speaker is saying."[46] This implicit social obligation prompts more active cognitive processing as "the learner works harder to select, organize, and integrate incoming information."[47] Whichever of these routes accounts for the effect, a professor can increase students' understanding—particularly their ability to apply principles to new situations—simply by adopting a conversational tone.

These findings, like the ones discussed above, hold significant implications for legal education. Many law school classrooms retain a formal air that may hamper learning. Legal materials themselves project a formal tone; statutes and judicial opinions speak with an authority that adds a layer of impersonality to complex material. And although most law school classes have shed the aura of dread that marked earlier eras, they remain more formal than most other educational settings. Deepening comprehension in law school may require legal educators to rethink the conventional classroom climate.

III. COGNITIVE SCIENCE AND CLASSROOM TECHNOLOGY: CAPITALIZING ON POWERPOINT

The principles outlined above offer numerous avenues for retooling legal education. Just as in the classroom, however, abstract ideas gain form through application. In this Part, I explore the three principles of learning theory as applied to an increasingly pervasive technology: PowerPoint. PowerPoint's novelty makes it a good vehicle for exploring pedagogy; few professors have used the tool long enough to develop deeply rooted assumptions about its value. Many professors, moreover, are struggling to use this technology effectively in the classroom. Insights from cognitive science could substantially improve current practices.[48]

questions. *Id.* at 391.

[44] *Id.*

[45] *Id*. at 394.

[46] Mayer, *supra* note 40, at 202.

[47] *Id.*

[48] Critics have denounced PowerPoint presentations in law and other venues as "superficial," "smarmy," "stupid," or "incoherent." EDWARD R. TUFTE, THE COGNITIVE STYLE OF POWERPOINT 5, 11, 16, (2004); *see also* Russell J. Craig & Joel H. Armeric, *PowerPoint Presentation Technology and the Dynamics of Teaching,* 31 INNOVATIONS HIGHER EDUC. 147, 147-148 (2006), http://springerlink.com/content/d07282073378x001/

The cognitive science principles outlined in Part One explain some of the pitfalls that professors encounter while using PowerPoint. The technology can overwhelm working memory with cascades of color, animation, and sound; too many speakers overuse PowerPoint's special effects. The software also encourages some instructors to read aloud from their slides, a practice that further burdens working memory. PowerPoint poses particular dangers of overriding a professor's personal contact with students.

When used thoughtfully, on the other hand, PowerPoint can advance the cognitive science principles that are essential to good learning. The medium's greatest strength lies in its ability to project visual images. Tapping that capacity enhances right brain thinking, increasing students' ability to synthesize complex materials and see the big picture. PowerPoint also supports several techniques for expanding working memory, enabling students to master complicated material more readily.

Building on these insights, I offer ten practical guidelines for using PowerPoint in law school classrooms. These guidelines serve two purposes. First, professors can draw upon them to improve their PowerPoint presentations or to explore the medium for the first time. Second, the guidelines illustrate how faculty can apply cognitive science principles to specific classroom practices. After illuminating the principles in this way, I return in the final Part of the Article to the broader questions of cognitive science, technology, and legal education.

A. Use More Images and Fewer Words.

Most PowerPoint presentations, including those in law school classrooms, display far too many words. The software's bullet-point templates, combined with left-brain, textual traditions, encourage faculty to wallpaper their slides with words. PowerPoint's greatest strength, however, lies in its ability to transmit images. Graphics projected through PowerPoint can engage the right brain, depicting relationships among concepts more effectively than words alone do.[49] Tapping PowerPoint's visual channel, moreover, both expands working memory and increases the information stored in long-term memory.[50] If professors focus on PowerPoint's ability to convey images, rather than words, they can leverage the medium most effectively.[51]

?p=35e5c43195f5a488890a97960be20adb2&pi+1 ("Viagra of the spoken word" employed by "bullet-point dandies"); Ian Parker, *Absolute PowerPoint: Can a Software Package Edit Our Thoughts?,* THE NEW YORKER, May 28, 2001, at 76.

[49] *See supra* Part I.A.

[50] *See supra* Part I.B.

[51] Stephen Pinker, the renowned MIT psychologist, summed up PowerPoint's capacity to deepen comprehension through the effective use of graphics this way: "Language is a linear medium: one damn word after another. But ideas are multidimensional. . . . When properly employed, PowerPoint makes the logical structure of an argument more transparent. Two channels sending the same information are better than one." Parker, *supra* note 45, at 78.

PowerPoint's capacity to display images is especially important in creating anchor points for classroom learning. Students master new material by building clusters of information, gradually adding new data to each aggregation.[52] The process, however, depends upon the presence of starting points that are substantial enough to support further exploration. Comprehension, in other words, requires seed crystals.[53]

Legal education often ignores this fundamental requirement of learning. Law school textbooks and classrooms offer dense streams of information without giving students the initial reference points to which that knowledge can adhere. Without that initial anchor, the brain has difficulty remembering or manipulating detailed structures.

Providing anchors for learning does not require spoon feeding students detailed outlines or black letter rules. On the contrary, if professors give students appropriate starting points, they will be able to construct those outlines as the traditional case method demands. Seed crystals for learning often are simple images, pictures that convey the elements of a controversy or other problem.

For the purpose of demonstrating the use of learning anchors, recall the decision, *Vosburg v. Putney*, a case commonly included in first-year torts case books.[54] In *Vosburg*, a school child lightly kicked another child on the shin during class. The kick triggered a hidden pathology, requiring amputation of the leg, and the injured child sued his classmate. Torts professors use this case to introduce the students to the concepts of intent, contact, and damage in battery law.

Like other Tort instructors, I used *Vosburg* to teach these principles to students. Although I haven't taught Torts for several years, my brain still conjures a clear mental image of one child kicking another when I recall *Vosburg*. I have never seen a picture of the parties in that case; my brain

Marketing guru Seth Godin makes a similar plea: "PowerPoint presents an amazing opportunity. You can use the screen to talk emotionally to the audience's right brain (through their eyes), and your words can go through the audience's ears to talk to their left brain. That's what Steven Spielberg does. It seems to work for him." Seth Godin, *Really Bad PowerPoint (and How to Avoid It)* 6 (2001), http://www.sethgodin.com/freeprize/reallybad-1.pdf. *See also* Lawrence M. Friedman, *White Boards Go Digital,* 14 CBA REC., Sept. 2000 58, 58 ("The process of both talking and drawing creates a synergy that lends itself to communicating complex ideas. This is why football coaches and military strategists draw endless diagrams of their plays and battle plans.").

[52] *See supra* notes 25-26 and accompanying text. *See also* RICHARD E. MAYER, MULTI-MEDIA LEARNING 13 (2001) ("When people are trying to understand presented material . . . they are not tape recorders who carefully store each word. Rather, humans focus on the meaning of presented material and interpret it in light of their prior knowledge.").

[53] Seed crystals are small crystals that are used to grow larger crystals. Molecules adhere to the seed, mimicking its structure and eventually producing a larger crystal organized like the original seed.

[54] Vosburg v. Putney, 50 N.W. 403 (Wis. 1891).

undoubtedly borrowed this picture from another context. Nevertheless, this image fuels my understanding of both *Vosburg* and the elements of battery. Volumes have been written about battery law, but the single kick in *Vosburg* embodies much of those insights. What did the child administering the kick intend? What physical frailties did the other child's body harbor? What was happening in the classroom around the children? Why do any of these factors matter?

My mental image of the kick became a kernel around which I organized these ideas allowing me to add more nuances to the concepts of battery over time. I eventually organized my understanding of battery in a textual outline that I could use as a checklist for analyzing problems but my mental images of *Vosburg* and other cases preceded the outline. The human brain, unlike a filing cabinet, does not store information in outlines, checklists, or text folders. The brain stores information as relationships and concepts, with images rooting much of the superstructure. Mental pictures are an essential catalyst of learning, although the process happens so automatically that most of us no longer notice it.

Vosburg is a good teaching vessel partly because it generates a concrete image that students can use to anchor their exploration of intent, contact, and other aspects of battery. Students, however, differ in their ability to create these images and in the extent to which particular cases speak to them. Some students readily visualize classrooms, while others more easily generate images of soccer fields or tennis courts.

PowerPoint can fill these voids by supplying images that students can borrow to anchor their analysis of cases, statutes, and fields of law. By projecting a picture of a classroom kick as a backdrop to a discussion of *Vosburg*, a professor can give all students a mental image that will help them organize their understanding of the case. A professor might think the picture is superfluous because everyone knows what a kick looks like, but not everyone will keep that image in working memory while discussing *Vosburg*. Students without such an organizing image, a seed crystal to shape the discussion, will find the details of the court's analysis to be abstract and incoherent.

PowerPoint thus offers one way to address a learning gap that most students and professors do not even recognize. The formation of mental images to secure legal concepts is crucial. Without an anchoring image, legal concepts lack traction making it difficult to make sense of those abstract ideas. This is not a gap that professors can fill by offering additional verbal explanations, nor is it one that students can overcome by reading treatises, nutshells, or canned outlines. The missing link in understanding often is an image rather than words.

Professors can also use PowerPoint to illustrate more complex concepts, from the details of a multi-party business transaction to the connections among several judicial rulings. At every level of understanding, graphics can aid comprehension. PowerPoint makes creation, display, and manipulation of these graphics particularly easy. Students appreciate the use of visual images

in classroom presentations; surveys reveal their preference for PowerPoint presentations that include graphics.[55]

B. Show the Big Picture

Speakers often rely upon PowerPoint to record lots of detail. Law professors, for example, use slides to project key points from cases and statutes, to list the elements of a legal claim, or to outline the steps of a lawsuit. PowerPoint serves these purposes, but it is even more effective in painting the big picture.

The big picture can be hard to find in law school classrooms. Cases, problems, and legal claims require intense analysis of small points. While mastering the particulars, it is hard to remember the context. How does this issue relate to the holding? How does the holding relate to the cause of action? How does the cause of action relate to the field of law? How does the field of law relate to the society it serves? Law students spend most of their time hacking at trees with few opportunities to look at the forest.

Law professors already employ several techniques to combat this problem. They may open class by reviewing material from the previous day or positioning the new material in an existing framework. Periodic summaries and reviews also help students integrate pieces into the whole. But for much of class time, the big picture recedes far, far into the background.

PowerPoint can enhance and instructor's efforts to connect details and context. By combining text and graphics, PowerPoint slides create particularly effective intellectual roadmaps. A single slide can map relationships among several areas of the course. A series of slides can create a more flexible roadmap by "zooming in" to show more fine-grained relationships and "zooming out" to display broader ones.

These roadmap slides are particularly effective if professors leave them in the background while discussing more detailed material. Instructors often fear that they should match every part of a classroom presentation with a new PowerPoint slide. PowerPoint, however, can be quite effective when used as a stable backdrop for more detailed class discussion. Just as the bass player establishes a constant beat for other members of an ensemble, a PowerPoint roadmap can project an ongoing reminder of how the live discussion fits with underlying course material. Students can refer back to the slide whenever they need guidance.

Professors can also use PowerPoint to engage students actively in identifying relationships among materials. Some professors create tables that compare new principles with ones covered in previous classes, but leave some of the cells blank. Calling on students to complete the table is an excellent way to draw their attention to the big picture, enhance their understanding of

[55] Attila Szabo & Nigel Hastings, *Using IT in the Undergraduate Classroom: Should We Replace the Blackboard with PowerPoint?*, 35 COMPUTERS & EDUC. 175, 181 (2000) (noting that 64.9% of surveyed undergraduates asked for more graphics).

connections, and reinforce learning. Many professors already use this technique with handouts or blackboard exercises, but PowerPoint can improve the approach. Tables created in PowerPoint may be more legible than those jotted on the board or on overheads. The professor can also distribute the slide electronically either before or after class.

Finally, some professors combine PowerPoint and word processing programs to create concept maps that help students grasp the big picture. To create a concept map, the instructor copies key PowerPoint slides into a word processing document, then arranges the slides to illustrate the relationship among them.[56] Concept maps allow professors to display detailed slides while also providing a contextual overview. This technique demonstrates PowerPoint's flexibility in illustrating the big picture.

C. Create Adjunct Working Memory.

Learning law requires students to juggle multiple clusters of information. To understand a judicial opinion, the reader may need to remember the case's procedural posture. Another ruling may acquire meaning only if the student understands the complex business dispute that generated the controversy.

Faculty can easily manage these related clusters of information in working memory; they have already mastered the basics, so they can recall procedural rules, substantive principles, and business practices simultaneously.[57] For students, however, this process is much more difficult. Since they have not yet conquered the underlying concepts, attempts to combine distinct ideas—like the procedural posture and factual details of a case—may overtax working memory's narrow channel.

One way to address this problem is to use PowerPoint as an artificial supplement to working memory, a place to store information that must remain easily accessible. After asking students about a case's procedural posture, for example, a professor may summarize the procedural status on a slide. If the instructor leaves that slide on display while exploring other aspects of the case, students will be able to refer back to the procedural context at any time. This frees working memory to focus fully on the court's substantive discussion. At the same time, the procedural posture remains readily visible to students whenever they need to invoke that information.

Professors can use a similar technique when helping students integrate new material with previously learned principles. After asking students to recall the

[56] Ian Kinchin, *Developing PowerPoint Handouts to Support Meaningful Learning,* 37 BRIT. J. EDUC. TECH. 647, 648 (2006); Ian Kinchin, *Concept Mapping, PowerPoint, and a Pedagogy of Access,* 40 JBE 79 (2006). These maps are similar to "mind maps," a technique used for organizing information while researching, writing, brainstorming, and performing other tasks. For a general introduction to mind mapping, see Diane Murley, *Mind Mapping Complex Information,* 99 LAW LIBRARY J. (forthcoming 2007), *available at* http://ssrn.com/abstract=958633.

[57] *See supra* notes 25-26 and accompanying text.

earlier concepts, a process that strengthens long-term memory and future retrieval, the instructor can display those principles on a background slide. This frees working memory to concentrate on the new material, while allowing students to refer back to prior principles when necessary.

Both of these techniques work best when the PowerPoint prompt is a fairly simple visual cue or set of words. A detailed textual slide summarizing the previous material or the procedural posture of a case will consume working memory. But if it is possible to summarize a concept with a few words or a graphic after eliciting the details from students, this technique works very effectively to expand working memory.

D. Avoid Distractions

PowerPoint's abundant features tempt some professors to decorate slides with sound effects, complex transitions, animated characters, and multiple colors. These frills sometimes pique students' interest, but they can also interfere with processing legal concepts. Research suggests that distractions in presentation style can substantially impair learning. Irrelevant sounds and music, for example, significantly reduce students' retention of relevant material.[58] Equally important, these embellishments also reduce students' ability to apply accompanying concepts to new situations.[59] Animations can also reduce learning; several studies find that static diagrams teach more effectively than animations.[60]

Simplifying PowerPoint presentations allows students to focus on content. Professors who use a small number of complementary colors, simple templates, and unobtrusive transitions with their slides will enhance learning by reducing visual distractions.[61] Maintaining the same style throughout a presentation also reduces cognitive overload. An occasional stylistic change can effectively highlight a particularly crucial point, but frequent switches absorb valuable capacity in working memory.

A slide's content can also inadvertently distract students. Professors sometimes add "special interest" graphics to slides, such as pictures of the parties or places involved in a case. If these photos illustrate essential

[58] Richard E. Mayer & Roxana Moreno, *A Coherence Effect in Multimedia Learning: The Case for Minimizing Irrelevant Sounds in the Design of Multimedia Instructional Messages,* 92 J. EDUC. PSYCHOL. 117, 117 (2000).

[59] *Id.* at 123.

[60] *See, e.g.,* Richard E. Mayer et al., *When Static Media Promote Active Learning: Annotated Illustrations Versus Narrated Animations in Multimedia Instruction,* 11 J. Experimental Psych. Applied 256 (2005). With proper care, animations can enhance some types of learning; current research focuses on identifying ways to tailor animation so that it aids, rather than burdens, working memory. *See, e.g.,* Paul Ayres & Fred Paas, *Can the Cognitive Load Approach Make Instructional Animations More Effective?,* 21 Applied Cognitive Psych. 811 (2007) (summarizing recent research).

[61] For additional design suggestions, see *infra* Part II.9.

concepts, such as the key event in a dispute, they can deepen understanding. Some faculty members also use photos to humanize controversies; they want to convey law's personal impact as one of their primary points. But if graphics fail to depict an element that the instructor intends to stress, they will distract students from those central themes. The most recent generation of educational research establishes that interest-grabbing techniques like textbook sidebars do more harm than good; students remember the interesting sidelights but fail to learn the essential material.[62] Professors can deepen students' comprehension by choosing graphics that connect to their main points rather than sprinkling slides with "interesting" pictures primarily designed to attract attention.[63]

Some professors assume that students like PowerPoint's bells, whistles, and other "fun" features, but now that the software's novelty has dulled, viewers are more likely to find its special effects annoying. In one survey, 91% of students opposed the use of PowerPoint's sound effects in class; similarly, almost three-quarters of the students disliked animation.[64] Although the surveyed students generally appreciated classroom use of PowerPoint, they named "special effects" as their top annoyance with the medium.[65]

E. Don't Repeat.

PowerPoint critics lambast presenters who read their slides aloud.[66] This practice irritates audiences; more surprising, it reduces comprehension. When spoken words duplicate projected ones, the brain devotes some of its working memory to comparing the streams of visual and auditory data.[67] Monitoring overlap of the two information streams diminishes the brain's capacity for deeper learning.

Instructors who use PowerPoint to convey images or depict relationships automatically avoid this type of repetition: a speaker can discuss a visual

[62] *See, e.g.,* Clark & Mayer, *supra* note 11, at 319; Mayer & Moreno, *supra* note 29, at 48. .

[63] Separating meaningful graphics from tangential ones also helps clarify class content. Some presenters make these distinctions by creating a storyboard for their PowerPoint presentations. The storyboard embodies their central themes, and all graphics advance those themes. *See, e.g.,* CLIFF ATKINSON, BEYOND BULLET POINTS (2005). Law school classes do not lend themselves to elaborate storyboarding, but the same principle applies to choosing graphics that convey a class's main ideas.

[64] Wim Blokzijl & Roos Naeff, *The Instructor as Stagehand: Dutch Student Responses to PowerPoint,* 67 BUS. COMM. Q. 70, 73 (2004).

[65] *Id.* at 75.

[66] *See, e.g.,* Parker, *supra* note 48, at 79 (warning against "the sin of triple delivery, where precisely the same text is seen on the screen, spoken aloud, and printed on the handout in front of you."). *See also* Alison Sulentic, *Adventures in PowerPoint: Teach with Punched-Up Visual Aids and See the Difference,* THE LAW TEACHER (Fall 1999) at 1, 2 ("*hatred* would not be too strong a word to describe the emotion inspired by someone who reads slides aloud") (emphasis original).

[67] *See supra* notes 30-32 and accompanying text.

image but cannot repeat it. When using text slides, the best way to avoid repetition is to rigorously reduce the number of words on each slide. Slides can effectively convey main ideas with a single word or phrase while the speaker elaborates on them. Projecting key words in this manner is similar to displaying a central image; it allows students to construct knowledge around the key words.[68]

Some legal topics do require detailed textual slides. When discussing a statute, rule, or central passage from a judicial opinion, for example, a professor might project the relevant text on a PowerPoint slide. The most effective way to build upon a slide like this is to read aloud only a few key words or call on a student to identify those words. Reading the full text aloud, as many professors do, will reduce students' attention to the text; listeners will unconsciously track the accuracy of the instructor's articulation, lowering the attention available for comprehension. Highlighting a few elements of a detailed text slide orally produces better comprehension than reading the full slide aloud.

The perils of repetition, however, do not prohibit using PowerPoint slides for periodic review. Information that appears sequentially, rather than concurrently, can modestly increase learning.[69] After an oral discussion, therefore, some professors can offer a beneficial quick recap with visual slides.

F. Keep It Personal

One of PowerPoint's greatest drawbacks is its potential to disrupt an instructor's personal connection to the class. If the lights are dimmed, the professor focuses too closely on the slides, or the professor adopts a more formal tone to match the slide presentation, such that classroom immediacy suffers.[70] At the extreme, students may fix their attention so closely on the screen that the professor becomes a mere stagehand responsible only for advancing the slides.[71]

It is possible, however, to maintain personal contact with a class while using PowerPoint. Most modern classrooms have lighting that works well with

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[68] Stanford law professor Larry Lessig is a master of this approach; other presenters refer appreciatively to his style as the "Lessig Method." *See, e.g.,* Presentation Zen, The "Lessig Method" of Presentation, http://www.presentationzen.com/presentationzen/2005/10/the_lessig_meth.html (Oct. 7, 2005) (linking to other commentary).

[69] Kalyuga et al., *supra* note 33 at 578.

[70] *See, e.g.,* Steve Brearton et al., *50 Best Employers in Canada,* THE GLOBE & MAIL (Toronto), Dec. 29, 2006, at 69 (noting that top officers at FedEx abandoned PowerPoint presentations for quarterly staff meetings because employees found the sessions "formal" and "intimidating"); Sara Lepro, *Going Ape: Entrepreneurs Form Group,* INSIDE BUSINESS, Feb. 1, 2004, at 9 (describing business group that eschews PowerPoint presentations as "too *formal*").

[71] Blokzijl & Naeff, *supra* note 64, at 70. *See also* Parker, *supra* note 48, at 79 (PowerPoint substitutes "human display" for "human contact").

PowerPoint, eliminating the need to darken the setting. Others will support slides with the lights only slightly lowered. Preserving as much illumination as possible is one key to maximizing the human link between professors and students.

Another tactic is to resist opening class sessions with PowerPoint. An increasing number of professors welcome their students to the classroom with a slide announcing the day's topic. This adds polish to the class, but cedes the stage to PowerPoint. A more personal approach is to ready slides before class but delay projection until after class begins.[72] The professor can then greet the class personally without competing with her own slides.

Similarly, faculty who want to personalize their classes can complete their PowerPoint slides before class ends, turn off the electronics, and bid the class farewell in person. If a slide contains detail that students want to finish copying, the instructor can turn the projector back on after dismissing class or distribute slides electronically. Maintaining personal control over the opening and close of class sends a strong signal that the professor—rather than the computer—is in charge. It also relaxes the formal boardroom ambiance that PowerPoint can create.

Maintaining strong eye contact with students is another way to enhance classroom immediacy while using PowerPoint. Visual contact is the most potent element of immediacy; it can overcome other overtones of impersonality. Some professors find that PowerPoint naturally increases their eye contact because they no longer turn to write on the board or look down at an overhead transparency. Others have to remind themselves to concentrate on the class rather than the slides or computer monitor. Whatever their natural inclinations, speakers who train themselves to preserve eye contact while using PowerPoint significantly increase personal warmth in the classroom.

Students sometimes focus too intently on the PowerPoint screen or their own laptops in the high-tech classroom; this, too, interferes with eye contact and reduces immediacy. The professor can break this tendency by moving around the front of the room or walking into the classroom aisles. The eye naturally tracks movement, so students will shift their gaze when the professor moves. Using a remote device to advance slides makes it easier for some faculty to move in this manner, although others achieve effective results by moving between the podium and the class.

Gesturing more emphatically can also help reclaim the spotlight from PowerPoint. Hand movements increase immediacy, but big gestures are necessary to compete with the large screens in most classrooms. Gestures also

[72] PowerPoint easily supports this approach. Hitting the "b" key (for a black screen) or the "w" key (for a white one) at any time during a presentation will temporarily replace the slideshow with a blank screen. Touching any key resumes the presentation. If you don't like black or white screens, you can include a blank slide of any color at the beginning of your presentation. In this case, begin the slideshow but don't move beyond the initial blank slide until you are ready.

signal the speaker's relationship to the slides and the audience. Professors who use their hands to identify objects on the screen, for example, enhance their immediacy by demonstrating their personal connection to the presentation. A pointer, conversely, interjects yet another barrier between the speaker and the audience.[73]

Finally, faculty may need to guard against PowerPoint making their speech and posture unduly formal. Prepared slides encourage many presenters to adopt a more formal tone; they unconsciously match the orderliness of the presentation. Students, however, respond better to professors with relaxed body language[74] and they learn better from instructors who adopt a conversational manner.[75] Very subtle changes in language, such as substituting "you" or "your" for impersonal pronouns can greatly facilitate comprehension.[76] If instructors can combine an informal, conversational style with PowerPoint, they can capitalize on the benefits of both visual learning and immediacy in the classroom.

G. Be Interactive.

Some PowerPoint presentations deaden discussion, but others promote lively interaction: the difference lies in how the professor uses the medium. PowerPoint seduces many users into bullet pointing every piece of information they plan to cover in the classroom. Using PowerPoint this way can dramatically reduce interaction; no one wants to interrupt the flow of information.[77] But turning to write every point on the blackboard or an overhead transparency would have the same effect.[78] PowerPoint does not

[73] *See, e.g.,* Blokzijl & Naeff, *supra* note 64, at 72 (mentioning survey that shows audiences prefer personal gestures to pointers).

[74] *See supra* notes 36-37 and accompanying text.

[75] *See supra* notes 38-47 and accompanying text.

[76] *See* Mayer et al., *supra* note 43.

[77] *See* Douglas L. Leslie, *How Not To Teach Contracts and Any Other Course: PowerPoint, Laptops, and the Case File Method,* 44 St. LOUIS U. L.J. 1289, 1304 (2000) (providing a dramatic, and derogatory, description of this effect):

> In a law school where the door to the classroom is in the back and has a window, I invite you to observe a class where the professor is using PowerPoint slides. The room will be partially darkened and the professor will be talking. The students will not be talking. If you stand there for ten minutes, you are not likely to see a single student speak. In the unusual class where the professor tries to encourage student comments while Powerpoint slides are used, you will see that students appear to be focused not on what their classmate may be saying, and not much on what the professor is saying. Their attention will be glued on the Powerpoint slide like a first-grader focuses on Barney.

[78] Ralph Olliges, *From Talking at You to Talking with You: Reshaping PowerPoint for Interactive Learning, in* INTEGRATING TECHNOLOGY, *supra* note 3, at 65.

inherently quench discussion; it simply makes a didactic style so easy that faculty can fall into its trap.

Replacing bulleted text with graphics and essential words helps to restore classroom interaction. Some professors take a further step, composing PowerPoint slides specifically targeted to stimulating discussion. A professor, for example, can initiate discussion of a topic by projecting a photo that embodies a controversial aspect of the topic. A provocative photo will stimulate discussion more readily than verbal prompts. The photo may also convey nuances that an oral hypothetical omits. A photo of a police officer stopping a Black motorist, for example, can trigger a lively discussion of racial profiling. Details of the photo may provoke comments about the officer's body language, the interaction of gender with race, and the effects of skin tone and dress, all issues that add texture to the underlying discussion.[79]

Slides can also spark debate by displaying words that represent competing values at stake in a controversy. To prompt a policy discussion of wiretapping, for example, a professor might project the words "security" and "privacy" on a slide. The paired words will activate thinking and help students tie their ideas to those competing values. Students may also recognize arguments on both sides of the debate more easily when the two poles appear simultaneously on screen.

The key to generating discussion with PowerPoint is to keep slides simple and evocative. If slides display detailed lists of bullet points, students will simply defer to the outline. A list appears authoritative and complete; it also lacks the emotional impact of a police officer frisking a Black motorist or the single word "privacy." The most effective PowerPoint images promote discussion by making the essential features of a controversy concrete. These slides can also facilitate discussion by dislodging the instructor as the sole classroom authority; a captivating image will focus students on the issues raised by the slide, rather than on the professor's views. Under these circumstances, PowerPoint's tendency to overshadow the speaker can work to the professor's temporary advantage.[80]

Law faculty can also use PowerPoint to enhance student discussion of doctrinal hypotheticals. Displaying the critical words from a hypothetical, without repeating the entire question, will help students process the hypothetical and keep it in mind as discussion progresses. The full class will also be more likely to ponder the problem, rather than tuning out once the professor has called on someone else, because the visual prompt remains before them.

Professors can further promote active learning by interacting with their own slides. PowerPoint has a "pen" option that allows presenters to draw on their

[79] *Cf. id*. at 66 (describing a professor who used an image of Rosalind Franklin's DNA photo to provoke discussion of whether Watson and Crick used her photo and data without permission to further their own prize-winning work).

[80] *Id.* at 71.

slides while displaying them. The speaker can underline words, circle them, draw arrows, and make other marks. With a little practice, it is easy to highlight slide content while speaking. Users with more dexterity can write words and draw images.[81]

Even more interaction is possible by adding a classroom response or "clicker" system to PowerPoint presentations. Turning Technologies makes a system, "TurningPoint," that integrates fully with PowerPoint. The TurningPoint software allows faculty to create slides that ask the entire class to respond to a hypothetical question. After students have registered their answers on individual clickers, the professor can display the range of responses on screen to offer feedback or stimulate discussion. Faculty can also poll students on controversial issues to trigger a policy debate. Response systems are available without PowerPoint, but PowerPoint add-ons make it easier for novice users to explore one of these systems. Students respond enthusiastically to clicker systems, and most faculty find that they greatly enhance interaction.[82]

Finally, it is always possible to promote interaction by turning PowerPoint off. Hitting the "b" key produces a black screen; touching the "w" key generates a white one. This technique abruptly refocuses attention on the speaker, allowing discussion to proceed without any on-screen distractions. Clicking the mouse or touching any key on the keyboard revives the slideshow where it left off.

H. Plan Outside PowerPoint.

PowerPoint's templates make it so easy for speakers to record their ideas

[81] To activate PowerPoint's pen function, press control-P any time after starting the slideshow. A small, unobtrusive dot (the penpoint) will appear on the screen. When you are ready to write, position the dot at the appropriate starting point, hold down the mouse clicker, and move the mouse: "ink" will flow from the penpoint. Release the clicker to stop writing or move to another place on the screen.

If you do not remember "control-P," you can also right-click at any time during the slideshow. This will make visible a menu of commands that are useful during a presentation. Choose "pointer options," then choose among the ballpoint pen, felt tip pen, and highlighter. The felt tip pen usually works best, and that is the one automatically produced by "control-P."

To change the color of your annotations, choose "pointer options" from this presentation menu and then select "ink color." You can also erase annotations during a presentation by selecting "eraser" from the same menu. This will generate an eraser-shaped icon. By clicking and moving it over an annotation, you will erase that annotation—but not the underlying slide.

While the pen is activated, you will not be able to change slides by clicking the mouse. But you can continue to advance slides by pressing the space bar or enter key.

[82] For more discussion of "clicker" systems in legal education, see Paul L. Caron & Rafael Gely, *Taking Back the Law School Classroom: Using Technology to Foster Active Student Learning,* 54 J. LEGAL EDUC. 551 (2004).

that some professors use PowerPoint to plan their classes. This approach, unfortunately, can produce the text-heavy, bullet-point-laden slides that are least effective for learning. To use PowerPoint well, presenters need to step outside the software and employ it strategically.

Planning the central concepts of a class before turning to PowerPoint helps maximize the software's impact. With the substantive themes in mind, it is easier to choose images, graphics, and text more selectively. Remembering PowerPoint's distinctive strengths also helps winnow slides. Use the software to show graphics, highlight key ideas, and provide roadmaps. If a slide doesn't perform one of the tasks at which PowerPoint excels, it may impair learning. Many classroom moments fare better without PowerPoint.

PowerPoint's inventor intended to give speakers just this sort of control; he developed the software to allow presenters to design their own slides rather than having to rely on graphic artists.[83] Marketers then "enhanced" PowerPoint by creating automatic templates and design wizards that can overpower the user. By resisting these devices and planning classes outside of PowerPoint, professors can wrest control back from the software.

I. Master a Few Design Principles

Because PowerPoint is a visual medium, it benefits from proper design. Law professors can greatly enhance classroom comprehension by learning a few design principles. Here is a quick guide to PowerPoint design, informed by cognitive science research on perception:

1. Background

PowerPoint offers hundreds of designer templates, but a plain background works best for educational purposes. Detailed background designs distract students and compete with slide content. Even logos or small embellishments can absorb valuable screen space and mental attention. If a logo or other small design seems necessary, one of the bottom corners offers the least obtrusive position. The best bet for classrooms, however, is a simple background color.

2. Color

Both dark and light colors offer suitable backgrounds for PowerPoint; the key is to pair white text with dark backgrounds and black text with light ones.[84]

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[83] Parker, *supra* note 48, at 77.

[84] Some presenters vigorously advocate dark backgrounds and white text, while others prefer the opposite. One authority on making PowerPoint accessible suggests that black text on a light background works best in well lit classrooms, while white text on a dark background is more visible in darkened classrooms. The Open University, Making Your Teaching Inclusive, *Accessibility and PowerPoint,* http://www.open.ac.uk/inclusiveteaching/pages/inclusive-teaching/accessibility-and-powerpoint.php (last visited Feb. 4, 2007). Since lighting conditions and color schemes vary so widely, the best approach is to

Colored text on any background shade is more likely to jump or vibrate on the screen and can raise problems for color-blind readers.[85] Many of PowerPoint's templates suggest varying color to highlight words, but this can have unpredictable effects. Some colors that PowerPoint suggests for emphasis make words *less* visible on screen. Using bold or italicized fonts usually works better to indicate emphasis.

Full color photographs project well on PowerPoint slides. For maps, charts, and other diagrams, however, it is best to use no more than four colors; too many hues make the graphic hard to read from a distance. If a diagram requires more than four colors to convey an idea, it is probably too complex for a single slide. Remember the narrow constraints on working memory;[86] if a graphic needs eight different colors to express its meaning, students will have difficulty interpreting it during class.

3. Font

A font size of 32-44 points for titles and 24-32 points for text usually keeps text readable from the back of the room.[87] Sans serif fonts, which lack finishing strokes, or "feet," are easier to read on slides than serif fonts, so most professional presenters use a plain sans serif font for text.[88] Mixing fonts, as many of PowerPoint's pre-set templates suggest, can unnecessarily jar the reader. A set of fonts from the same family will more smoothly distinguish titles, text, and emphasized words. Arial Black, Arial Bold, and Arial Italic, for example, could appear together on slides to convey titles, text, and emphasis.[89]

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preview your slides in the classroom and lighting conditions where you will most often display them.

[85] PowerPoint imposes fewer burdens on color-blind viewers than many professors fear. Presenters should avoid using color as the exclusive means of conveying ideas; combining color with shapes or text assures greater accessibility. Avoiding pure red and green hues is also wise; these are the hardest colors for color-blind students to distinguish. A free internet program, finally, allows presenters to view their slides as color-blind individuals would see them; this program can reveal any problematic color combinations. *See* Vischeck, http://www.vischeck.com/ (last visited Feb. 5, 2007). For further discussion of accessibility to PowerPoint in the law school classroom, see Deborah J. Merritt, *PowerPoint for All: Simple Guidelines for Making PowerPoint Accessible to Disabled Students* (June 16, 2007) (unpublished).

[86] *See supra* notes 17-19 and accompanying text.

[87] Julie Terberg, *Font Choices Play a Crucial Role in Presentation Design,* Presentations, Apr. 2005, at 16, 17, http://terbergdesign.com/images/PDFs/Apr_05CTjt.pdf. Terberg is a highly regarded PowerPoint designer.

[88] *Id.* at 16-17. In hard copy documents, on the other hand, research suggests that serif fonts are slightly more legible than sans serif ones. *See* Ruth Anne Robbins, *Painting with Print: Incorporating Concepts of Typographic and Layout Design Into the Text of Legal Writing Documents,* 2 J. ASS'N LEGAL WRITING DIRECTORS 108, 119-20 (Fall, 2004).

[89] Terberg, *supra* note 87, at 17.

For emphasized words, bold fonts are most effective.[90] Italicized words can also convey emphasis, but italics are most readable when applied to isolated words rather than a full phrase or sentence.[91] Underlined words can be difficult to read on slides.[92] Some presenters show emphasis by increasing font size slightly or drawing a box around emphasized words; these techniques also work.[93] Words or headings written with all capitals, on the other hand, are very hard for readers to process; they are worth avoiding at all costs.[94]

J. Extend PowerPoint Outside the Classroom

Some of PowerPoint's most innovative applications occur outside the classroom. For example, some professors have created slideshows that allow students to review difficult course materials. Using PowerPoint, faculty can craft multimedia tutorials, combining text and graphics to explicate complex concepts. Lengthy text on the slides is less troubling in this context than in the classroom because each student can read the slides at his or her own pace. These PowerPoint tutorials are simple to distribute to students or attach to websites.

Other professors use PowerPoint to create practice problem sets or exam questions for students. One way of doing this is to pose a short-answer question on one slide and answer it on the next. Students click through these slides to test their comprehension levels. Another approach uses a sequence of slides to walk students through a more complex hypothetical. After presenting a hypothetical on one slide, the professor creates a series of slides showing students how to reason through the answer. A Torts hypothetical, for example, might describe a shoving match that results in a serious injury. The first answer slide might read: "This looks like a battery. What are the elements of battery?" The next slide would recount those elements and ask whether the first element was met. Succeeding slides would apply the principles of these elements to the facts in the hypothetical.[95]

Slide shows like this have a significant advantage over conventional model answers and handouts, because they guide students through the reasoning

[90] *See* Robbins, *supra* note 88, at 118-19 (reviewing research on impact of bolding words compared to italicizing or underlining them).

[91] *Id.*

[92] Terberg, *supra* note 87, at 17. Studies similarly suggest that underlining slows reading of hard copy documents. *See* Robbins, *supra* note 88, at 118.

[93] Terberg, *supra* note 87, at 17. Boxes can be adjusted to avoid interfering with descending letters as underlining does.

[94] *See* Robbins, *supra* note 88, at 115-18 (discussing extensive research on fully capitalized words in documents).

[95] *Cf.* Michael Hunter Schwartz, *Using Course Webpages to Improve Student Learning: Theoretical Justifications and Concrete Examples*, at 3-4 (Jan. 26, 2007), http://ssrn.com/abstract=959682 (describing a similar process of using course websites to provide "cognitive think aloud" answers to exam questions).

process one step at a time. A typical model answer or class handout, with its welter of issues, rules and facts, can overwhelm students who are just learning the material. PowerPoint slides help students focus on one step of reasoning at a time, nudging them slowly through the entire process.[96] New learners can also return to previous slides if they lose the thread of an argument. By capitalizing on these features of PowerPoint, professors can develop learning tools that complement and enhance more conventional approaches.

The easiest way to extend learning through PowerPoint is to distribute slides to students. Some professors resist sharing slides because they fear students will skip class and rely exclusively on the slides, but if the slides simply highlight and illustrate material, as learning theory recommends, the slides will lack meaning without the professor's classroom input. Professors who post slides before class enable students to annotate images and concepts as class proceeds. However, even if slides are posted after class, they can provide an important learning tool that students can refer to throughout the semester.[97]

IV. REFLECTIONS ON THE FUTURE: COGNITIVE SCIENCE, CLASSROOM TECHNOLOGY, AND LEGAL EDUCATION

Legal educators have always prided themselves on their pedagogy. The case method, developed more than a century ago, is distinctive among higher education. The approach has unique characteristics, differing from case and problem methods used in other fields. The question-and-answer style of law school professors is also singular; no other discipline stimulates learning in just this manner. Clinics and skill training have also thrived in law schools, inspiring imitation in related fields. Using these and other unique methods, law professors pride themselves on teaching students critical thinking rather than black letter rules or isolated pieces of data.

Legal education's pedagogy, however, is largely introspective. Educators compare their own approaches and curricula with others in the legal profession without noting the perspectives of experts who study learning in other fields. Many legal educators assume that law is "different"- so different, in fact, that it cannot benefit from techniques used to teach math, chemistry, sociology, literature, medicine or other subjects. Although legal educators increasingly

[96] A growing body of educational research demonstrates that "worked examples" help students master complex concepts when they first study material. *See, e.g.,* William M. Carroll, *Using Worked Examples as an Instructional Support in the Algebra Classroom,* 86 J. EDUC. PSYCHOL. 360 (1994); Richard E. Mayer & Jill L. Quilici, *Role of Examples In How Students Learn to Categorize Statistics Word Problems,* 88 J. EDUC. PSYCHOL. 144 (1996). However, after gaining expertise, unaided problem solving may be more effective. *See, e.g.,* Slava Kalyuga et al., *When Problem Solving Is Superior to Studying Worked Examples,* 93 J. EDUC. PSYCHOL. 579 (2001).

[97] Research suggests that giving students a note-taking outline before class improves both note-taking and learning. *See* Schwartz, *supra* note 95, at 2-3. PowerPoint slides are one way to offer such an outline.

look to other disciplines to illuminate legal doctrine, they rarely pause to see what those fields can teach them about education.

While legal educators have been minding their own educational garden, cognitive scientists have made path-breaking discoveries about how the brain functions. At the same time, new technology has generated a bewildering array of new learning and communication methods. In this final Part, I offer several reflections on how cognitive science and classroom technology inform legal education. I first address the three cognitive science principles outlined in this Article, suggesting further ways in which each of them might improve legal training. I then consider the need to educate law students more directly about how the brain functions, to teach them about the process of thinking. Finally, I examine the role of new learning technologies both in preparing students for evolving legal practices and in stimulating the assessment of legal education itself.

A. Three Principles Revisited

Cognitive science offers numerous lessons for educational practice. The field has already produced a large number of insights, and it continues to yield significant discoveries about how the brain works. The concepts of right brain thinking, working memory, and immediacy provide critical starting points for reshaping legal education.

1. Right Brain Thinking

Understanding the relationship between left and right brain processes sheds useful light on classroom tools like PowerPoint. The role of right brain thinking, however, is even more crucial when examining fundamental aspects of legal education. Legal educators have long recognized the primacy of problem solving, critical thinking, and counseling in law practice; these are all activities that depend upon perceiving connections among ideas, fitting data into context, and other right brain perspectives.

But right brain thinking seems less prominent in law school classrooms than it once was. How can faculty resist legal education's slide into detail, linear thinking, and other hallmarks of left brain processes? To develop the right brain fully, it may not be enough simply to add more holistic experiences, like clinics and problem solving courses, to the law school curriculum. Legal educators may need to rethink some of the basic characteristics of law school instruction.

The case method, for example, bears a curious relationship to right brain thinking. On the one hand, cases illustrate the operation of legal principles in context; students see how the facts of a particular dispute generated a judicial resolution. Similarly, synthesizing case holdings gives students practice in connecting ideas to create a larger whole. Applying the principles of a case to hypothetical variations, finally, allows students to build clusters of knowledge and further explore the relationship of legal principles to facts and context. These associations with right brain thinking contribute to the case method's

success and longevity.

On the other hand, the case method suffers from three flaws that increasingly compromise its effectiveness in promoting right brain thinking. First, the factual context offered by appellate opinions is stunted. Students do not see the complex facts of a human dispute; instead, they see the facts filtered by trial preparation, governing legal principles, and litigation. The narrow factual record recited by an appellate court is sufficient to provoke contextual thinking during the early days of law school, but a steady diet of these abstract statements will not continue triggering deep contextual associations over time. This may be part of the reason why students turn off of the case method, seeming less engaged in cases as law school progresses.

Second, all of the problem solving skills and contextual thinking taught by the case method center on appellate litigation. Professors sometimes pose classroom hypotheticals that attempt to construct other contexts (e.g., they ask students how they would counsel a client in light of a particular judicial decision, or draft a contract to respond to a court's ruling). But these questions really ask students how they would insulate a client against a potential appellate battle. The question is no different than asking students directly how they would argue the point in a subsequent appellate case. Whatever question a faculty member asks, she seeks essentially the same answer: one that focuses on a legal point resolved in an appellate context. The typical law school classroom and textbook do not give students any other context, so these hypotheticals do not stretch the brain beyond the bounds of appellate decision-making.[98]

This point differs from the more common complaint that the case method fails to teach students practice skills like fact gathering, counseling, and drafting. Those concerns also have merit, but law schools address them somewhat in clinics and skills courses. The deeper problem is that the case method never releases the brain from the narrow harness of appellate litigation. By presenting the same context repeatedly in law school, professors hamper students' ability to build other intellectual frameworks and manipulate ideas more broadly. Even with expanded clinical opportunities, problem solving courses, and drafting seminars, law students spend the majority of their educational time in doctrinal courses. If all of those courses employ the case method, faculty give students little opportunity to flex their mental muscles beyond the appellate context.

Finally, the case method today is cracking under the weight of too much

[98] Imagine, for example, a student who responds to a classroom hypothetical about client counseling by saying, "I would advise my client that the hassles, expense, and emotional burden of litigation are not worth enduring to pursue this issue." The professor would laugh, and might even compliment the student on the answer, but probably would continue questioning the class until he received the doctrinal analysis he was seeking. That analysis, even if couched in terms of advice to a client, would be indistinguishable from the substance of an appellate brief or subsequent judicial opinion on the matter.

law. The right brain benefits of the case approach require deep exploration of individual cases. This ideal is occasionally achieved during the first weeks of law school, but the extraordinary press of new areas of law, innovative legal doctrines, interdisciplinary perspectives, and other novel content soon forces truncation of the case method. Today, the traditional method often consists of discussing an appellate opinion quickly as an example of a particular principle, offering an interdisciplinary perspective on the principle, applying that principle briefly to a few hypotheticals, and moving on to the next case. These are all worthwhile contributions to learning, but they are primarily left brain accretions of information. An overburdened case method lacks the right brain potential that the method initially promised.

In light of these flaws, illuminated by cognitive science perspectives on right brain thinking, faculties should explore alternative methods of structuring legal education. Doctrinal classes do not need to abandon the case method entirely; indeed, most subjects benefit from extended discussion of selected cases in the field. But legal educators should ask whether appellate opinions really are the best way to study every point of law. Straightforward exposition of basic principles, accompanied by concrete, easily pictured examples, might teach basic principles more efficiently, allowing time for development of right brain thinking within the context of more carefully chosen problems, cases, and statutes.

2. Working Memory

The constraints of working memory pose one of the most serious challenges to legal education. Legal rules, procedures, and applications are complex; they can overwhelm even the most adept brain. Law school's traditional response to the limits of working memory has been a "sink or swim" attitude. Students are left to flounder in a welter of cases, holdings, statutes, and other detail, hoping to work their way out of the confusion eventually.

The sink-or-swim approach may have worked when professionals taught less law. Students had time to sort through the details, develop organizing principles, and recapture elements they lost when working memory overflowed. It is less clear that benign neglect of working memory's limits will work today. Students eventually master much of the material given to them, but their mastery may be more superficial. If classroom instruction regularly exceeds working memory and students glean the lost material from nutshells or course outlines, their comprehension will reflect the limits of those sources.

Law professors should take a hard look at the constraints of working memory. If educators understand how that channel functions, they can adopt techniques that maximize students' learning. Professors can also pace material so that students learn it more efficiently. Law students today are as smart as they have ever been, and the brain has the capacity to master large amounts of complex legal material. But instructors need to tailor the increased load of legal education needs to fit the constraints of working memory. Law schools

will accomplish their educational goals only by recognizing the brain's limits.

3. Immediacy

The traditional law school classroom was an unfriendly place: students seated in alphabetical order, a scowling professor firing questions into the class ranks, students dreading their turn to speak, and the professor disdaining any answers that fearful students managed to supply. The climate in most classrooms has warmed up considerably since those days. Legal education, however, still falls short of attaining the full benefits that immediacy can confer.

Many law school classes unfold as performances rather than engaged conversations. The professor offers a series of questions and hypotheticals, often reprised from previous years. The students, who tried to divine the questions before class, deliver answers that they hope will satisfy.[99] Engagement and discussion occurs, but the exchanges often have a stilted or arms-length tone. Analysis in large "Socratic" classes rarely achieves the brainstorming quality that a group of lawyers, genuinely involved in trying to solve a client's problem, might display.

If professors recognize this lack of immediacy, they can find ways to address it. Some faculty occasionally divide their classes into small groups for critical thinking sessions that report back to the full class. Others cultivate an informal air by calling students by their first names and projecting a relaxed image in other ways. Some invite students to respond periodically to questions through a classroom response system; the technology involves all class members, provides immediate feedback, and elevates student comfort through anonymity.[100]

Other techniques may be as good as or better than these in developing immediacy. Immediacy is, by definition, a reflection of each professor's personality; instructors create the highest immediacy when they adopt classroom methods reflecting themselves. The essential point is to recognize the effects of personal interaction on education and to find ways to increase that quality in law school classrooms.

B. Educating Students about the Brain

Cognitive science offers multiple insights for improving law school education. Equally important, this research allows faculty to provide students

[99] In the first year, students often try to anticipate literally the questions that the professor will ask. At the least, they learn to read assignments with the professor's potential questions in mind. In upper-class years, many students lack the time or interest to prepare this thoroughly for every class. But they will often prepare this type of performance for selected classes, particularly if the professor uses an "on call" system that tells students when they will be responsible for classroom responses.

[100] For further discussion of classroom response systems, see *supra* note 79 and accompanying text.

with sophisticated information about the best ways to learn. Explaining the limits of working memory to law students will help them develop their own techniques for handling the dense information flows of law school. Outlining the processes of right and left brain learning will encourage students to use the case method most effectively, focus on the process of synthesizing, and identify new techniques for building clusters of related information. Law students are preparing for a profession that makes constant demands on their intellectual capacity. Giving students tools to manage that capacity early in their education will serve them throughout their legal careers.

It no longer suffices to teach students how to think like lawyers. Instead, it is necessary to teach them how and why lawyers think the way they do, as well as the many styles of thinking that lawyers adopt. Cognitive science illuminates the mental tasks that all lawyers perform: acquiring information, analyzing problems, and communicating ideas. By learning how the brain performs these functions, lawyers can improve their success at tasks as diverse as drafting wills, pitching services to a new client, and organizing evidence for trial. As law graduates face rapidly changing economic and cultural conditions in practice, they can draw upon basic cognitive science principles to adapt their intellectual capacities to face diverse challenges.

C. The Special Role of New Technologies

New technologies, like the PowerPoint software discussed in this Article, play a special role in legal education. Because lawyers are professionals who learn, think, and communicate, they must remain open to new tools for accomplishing those ends. Some law graduates may prepare PowerPoint presentations more often now than they write legal memos or appellate briefs.[101] If legal educators ignore these new technologies or use them badly, law students will lack essential skills when they enter the workplace. Conversely, if faculty employ new technologies effectively in law school classrooms, students will learn from their example.

New technologies, finally, illustrate the learning process more readily than accepted instructional methods do. Law professors are so familiar with the case method and other standard practices in legal education that it is hard to view those approaches objectively. It is difficult to dissect these conventional methods and assess them through the lens of cognitive science. New learning methods provide valuable opportunities to explore how the brain works. We can "see" those mechanics more readily in an unfamiliar context than a

[101] PowerPoint applications in law practice include sharing information with clients, educating colleagues, organizing information for dispute settlement, and presenting persuasive arguments to the jury. One trial lawyer recently credited a well-designed PowerPoint presentation with helping to secure a $15 million jury verdict. *See* Tina Bay, *Jury Awards $15 Million to Woman Injured in Crash with Sheriff's Deputy,* METRO. NEWS ENTER., June 29, 2006, at 3. According to the successful lawyer, a slideshow featuring primarily graphics had an "extraordinary effect" in focusing the jury's attention. *Id.*

familiar one, much as we can recite the rules of grammar in a foreign language better than in our own. As learning technologies continue to evolve law professors can use these innovations both to improve teaching and to learn more about their own methods.

V. CONCLUSION

Change is the new constant in legal education. As law practice, global culture, and the economy shift, law schools struggle to keep pace. But two advances can help professors cope with these challenges. Cognitive scientists have uncovered fundamental principles about how the brain works, allowing faculty to teach, learn, and communicate better than ever before. Emerging classroom technologies, meanwhile, have provided new tools to implement those insights. By drawing upon the discoveries of cognitive science and exploring the potential of new technologies, law professors can enrich their teaching and enhance the intellectual assets that graduates take with them into the workplace.