Educating for Seapower

Developing intellectual agility through active learning

by Dr. Mie Augier & Maj Sean F.X. Barrett

"There is more to sustaining a competitive advantage than acquiring hardware; we must gain and sustain an intellectual overmatch as well."[1]

—Joint Chiefs of Staff

The *Education for Seapower* (*E4S*) study, former Secretary of the Navy Richard V. Spencer's subsequent decision memo laying out a sweeping reform of naval education, the establishment of the Navy's new Director of Warfighter Development office, and the *Commandant's Planning Guidance* (*CPG*) all emphasize the importance of thinking and education to enhancing our warfighting capabilities. Following on the heels of the 2018 *National Defense Strategy*'s diagnosis that professional military education (PME) has "stagnated,"[2] these strategic documents and actions reflect a broad understanding that training and education must move beyond an industrial era paradigm in order to enhance the intellectual agility and preparedness of our warfighters. However, despite this level of understanding, organizational transformation is not going to be easy. It never is. The *E4S* strategy is already under increasing scrutiny, and the Department of the Navy eliminated the expansion in funding for implementing the strategy from its Fiscal Year 2022 budget request.[3] Some earlier landmark reports that influenced education in remarkable ways also faced pushback, delays, and misunderstandings along the way.[4] Even the Knox-Pye-King Board report, which helped inspire *E4S*, was at first thought impractical, and opponents attempted to suppress it.[5] In fact, it is sobering how closely Gen David H. Berger's *CPG* reflects Gen Al Gray's initial guidance concerning the development of a "Concept for Education" over thirty years ago—suggesting that despite a lot of effort from a lot of people, we still have not nudged our training and education system far enough beyond the industrial era paradigm, or else at some point we lost our way. [6]

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People and organizations usually do not embrace change easily, and various kinds of individual, organizational, and bureaucratic inertias run deep. Thus, even though Training & Education Command is making encouraging strides toward revamping various training and education curricula, any enduring or lasting change is going to require careful attention over a long period of time as well as a firm understanding of the intellectual foundations and instructional designs needed to make this paradigmatic change possible.[7] It is in this spirit that we write this article. In previous articles, we have tried to explain some of the themes and intellectual emphases in *E4S* and the *CPG*, including leadership aspects useful in the post-industrial era ("Leadership for Seapower," *MCG*, Dec2019) and the learning foundations for such skills ("Learning for Seapower," *MCG*, Nov2020). Here, we focus on explaining some of the foundations and dimensions of intellectual agility and highlight why training and education institutions must leverage active learning approaches to help build and shape the intellectual agility of our warfighters. The Joint Chiefs of Staff underscore the importance of agility and transforming leader development and PME: "Our country requires warfighting leaders and staff officers capable of waging war and leading in a dynamic, globally integrated environment."[8] Our observations are guided by a steadfast belief in the maneuver philosophy, which embraces the criticality of developing agile minds (and

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institutions) and empowering our warfighters to make decisions in situations marked by stress and ambiguity, as well as the understanding we can do so by learning some valuable lessons from our own history.

> ***"The 21st Century demands American officers be far better educated and more capable of directing and integrating the Nation's military instrument."[9]***
> ***—Joint Chiefs of Staff***

Educating for Agility and Lifelong Learning: A Few Ideas

The shift from the industrial era to the post-industrial era has changed the types of problems typically encountered, the most effective ways to organize, and the types of skills useful for future leaders. Some of the most important features of the post-industrial era include dynamics, change, and temporality as well as the corresponding need to shift away from static approaches and instead place a greater emphasis on educating for thinking and judgment. This sentiment is rooted in Marine Corps history, notably during the maneuver warfare movement under the strategic leadership of Gen Gray, who stressed, "Above all else we try to orient our training upon the cultivation of attitude that the only thing certain on the battlefield will be the uncertain—the unexpected." Leaders, according to Gray, must be able to *think*, be empowered to seize and maintain the initiative, and "view uncertainty as an advantage to be capitalized upon, rather than a disadvantage that inhibits their options."[10]

Cultivating intellectual agility to take advantage of uncertainty is an especially important topic for our training and education institutions, since it not only encompasses curricula and teaching materials but also how we organize and lead these institutions and the instructional approaches we employ. Identifying a few relevant foundations and dimensions relating to intellectual agility and preparedness is thus prudent before discussing their implications for training and education.

Broadening minds. Given today's "increasingly complex global security environment,"[11] developing leaders who can think through ambiguous and changing situations, anticipate and adapt to change, and proactively problem solve and innovate thus takes on added importance.[12] Leaders with agile, active, and broad minds can apply knowledge to new and unforeseen situations and transfer knowledge between seemingly disparate domains. This, however, necessitates a shift from teaching students *what* to think to *how* to think.

Col Mike Wyly, for example, rewrote the entire curriculum at Amphibious Warfare School after being named Head of Tactics in 1979 in order to teach students how to make decisions rather than methodical decision-making processes they would never use in real war. He notes the implication for teachers: "His mission ... is to teach students to think, to exercise judgment. It is not to teach a repertoire of attacks or formulistic procedures." In fact, the objective of any course or block of instruction is "not about imparting knowledge. It is about teaching judgment. There are no rules or formulas."[13] Focusing on helping leaders think abstractly and make connections across a range of problems is more conducive to developing judgment than teaching a tool that is limited to a particular field or already identified problem.

Beyond hammers and nails. The prevalence of dynamics, change, and temporality demands integrative, pluralistic approaches not only concerning disciplines and domains of knowledge but also the methodologies we use. Training for specific tools and techniques might have proven adequate to meet the demands of the industrial era. However, a shift from repetitive, well-structured problems to ambiguity, uncertainty, and ill-structured problems requires a corresponding increase in the imagination, innovativeness, and critical thinking abilities of our leaders. They must be able to frame, think through, understand, and solve problems featuring an increasing number of interdependencies.

Technology maintains the allure of a "quick fix," but it certainly is not a long-term solution, as particular tools can quickly become outdated and lead to a myopic view of (and solutions for) complex problems.[14] Thinking, rather than tools or technology, remains the central premise of maneuver warfare. Gen Gray explains,

> [M]aneuver warfare isn't so much a function of how you are equipped as it is a function of how you think. We ... concentrate on making the maximum use of the tools that are at our disposal rather than waiting for wish-list technologies to solve our problems.[15]

> ***A major goal of teaching problem solving and critical thinking should be preparing the student for lifelong learning by inculcating the skills of self-instruction.***

Concerning training and education in particular, this means we need to be aware of the potential pitfalls of educators (implicitly or explicitly) providing their students increasingly stronger hammers to use on increasingly small nails that are no longer relevant in the post-industrial era.

Educating for lifelong learning vs. checking the box on a requirement. A major goal of teaching problem solving and critical thinking should be preparing the student for lifelong learning by inculcating the skills of self-instruction.[16] This is important because, as *FMFM 1* reminds us, "every Marine has a basic responsibility to study the profession of arms on his own. ... This is particularly

true among officers; after all, an officer's principal weapon is his mind."[17] Unfortunately, as the *CPG* observes, the current training and education paradigm is based on passive learning, rote memorization, and regurgitation, which the philosopher and educator Mortimer Adler identifies as the doctrinal approach.[18] The doctrinal approach is based on teachers imparting as much truth as possible (and no errors) into students, whereas the goal of a more dialectical approach is the pursuit of truth and students learning how to think by identifying inconsistencies and contradictions across different authors and ideas and then determining which are correct.[19] The dialectical approach, according to Adler, more readily prepares students for continued learning after (or between) periods of formal training and education by cultivating learning skills, an understanding of ideas, and the motivation to seek an even greater understanding of these same ideas. What is understood becomes "habit of the intellect" and is not readily forgotten, in contrast to items merely committed (and then soon lost) to memory.[20]

Nurturing these skills is particularly relevant to reading and the self-study of history and war, which Col Wyly argues are requirements for developing military judgment. According to Wyly, leaders must "learn to analyze and make connections between battles of the past and battles of the future, and to conceptualize in order to deal with the unknown."[21] LtGen Paul K. Van Riper, the first president of Marine Corps University, similarly suggests,

> [History] does though provide a rich context for understanding the terrible phenomenon that was, is, and will remain war. The vicarious experiences provided through study of the past enable practitioners to see familiar patterns of activity and to develop more quickly potential solutions to tactical and operational problems.[22]

Thus, studying history must go beyond learning who won and who lost or identifying "lessons" or "recipes" for success for known problems. Active learning approaches are a critical element to effectuating lifelong learning and fostering the ability to read critically, think reflectively, and understand the larger context in which decisions were made. These skills are critical to simulating the experiences of others and making our minds more agile and able to adapt to new or different situations.[23]

"What the student gains from the case study is not a formula for achieving success, but a look at human behavior in combat, an understanding of the many variables involved, an appreciation of which variables weigh more under different circumstances, and some additions to his 'bag of tricks' for application in real war."[24]

—Col Mike Wyly

"The focus of effort [of PME] should be teaching through doing, through case studies, historical and present-day, real and hypothetical, presented in war games, map exercises, sand table exercises, free-play, force-on-force 'three day wars' and the like."[25]

—Gen Gray

Active Learning Approaches

The *CPG* directs us to change our current training and education paradigm to become more "focused on active, student-centered learning."[26] The current paradigm is based on what Herb Simon refers to as "the fallacy of rote memorization." Simon notes, "Rote memorization, as we know all too well, produces the ability to repeat back memorized material but not the ability to use it in solving problems."[27] Most decisions in battle are decisions of encounter that demand the ability to think quickly under the twin pressures of limited time and limited information as opposed to methodical set pieces that afford plenty of time to plan and the ability to make decisions at a time of the individual or organization's choosing.[28] While some of these decisions can be fairly routine and executed by following standard operating procedures, novel and ill-structured problems demand more intuition and judgment as well as the intellectual agility to recognize conditions and situational cues that are analogous to previous experiences and link these insights to appropriate actions. Leaders must be able to quickly reflect on similarities and differences and then translate and adapt the analogy to the current situation.[29] Thus, training and education must be focused on active practice in problem solving, increasing meaningful experiences, and making decisions rather than simply remembering.[30]

Military organizations, however, are limited in their ability to create realistic training scenarios that replicate actual conditions in war,[31] forcing them to grapple with the challenge of "learning from samples of one or fewer."[32] Individual experience can be enhanced by active, scenario-based learning methods that put students in complicated, unforeseen scenarios demanding decisions on short timelines.[33] Wyly cautions that if the teacher provides the student as much information as the student feels he needs, "then you have given him

too much. Combat decision making is decision making with incomplete information."[34] These active learning methods include historical case studies, sand table or map exercises, tactical decision games, terrain walks, or tactical exercises without troops. Basing these scenarios on actual historical events keeps the exercises rooted in reality and enables the student to study human behavior, which Wyly notes is "the essence of the determinant in battle," rather than simply theorizing.[35]

Active learning is based on the idea that learning has to occur in—and transform—the minds of students.[36] Tools of passive learning techniques like checklist rubrics and prescription solutions for exams and papers are impediments to this kind of transformation. Teachers should also be cautious about tailoring discussions and providing prompts, templates, or examples (e.g., of papers or projects) from previous classes that limit the creativity of students and "guide" them to a certain response or conceptualization. For example, Col Wyly recommends that instead of selecting an historical example to teach a given concept of maneuver warfare, the teacher should instead assign a reading and then ask the students what *they* discovered from the operation.[37] Rapid, logical decision making should be the goal, not "right" answers or following prescribed procedures.

Refocusing towards more active, transformational learning as opposed to the industrial era's emphasis on methodical teaching requires a significant amount of change on our instructors' and faculties' part, too. However, despite the enormous role instructors and faculty play in fostering an effective learning environment, they receive comparably little attention in discussions of training and education. It is seemingly assumed they are able (and willing) to adapt to any new teaching methodology, which, at best, takes some time. For example, even though active learning has been recognized as a superior method of classroom instruction, most college science, technology, engineering, and mathematics instructors still rely on traditional teaching methods (i.e., passive lectures).[38] Since teaching is a cooperative art, our instructors and faculty might also need to be retooled so they are capable of working with students and adapting to their capabilities.[39] Lastly, we must not lose sight that teachers, first and foremost, must be learners, and their instruction should require genuine intellectual activity on their part and not simply "professing" material that students memorize.[40] They (and our training and education institutions) must be comfortable teaching without set lesson plans and be flexible enough to follow the twists and turns discussions might take.

> ***"We must cease viewing PME as something less strenuous and less challenging than other tours of service, and seek to make it as competitive and rewarding as possible."***[41]
>
> **—CPG**

A Few Additional Trends in Education Relevant to E4S and an Invitation to the Pain of Learning

In addition to incorporating active learning methods, there are additional insights from, and trends in, civilian education that might be relevant to transitioning to a post-industrial era training and education paradigm.[42] David Epstein identifies chunking, interleaving, and testing as three important considerations in developing broad problem-solving capabilities. Chunking refers to the ability of experts to group multiple data points into smaller, more meaningful "chunks" based on pattern recognition derived from experience.[43] Relying too heavily on experience, however, can lead to deleterious results if too much emphasis is placed on identifying the first familiar solution available. In fact, successful reinforcement and reinforced pretraining both undermine one's ability to comprehend subsequent rule discovery, or *why* certain solutions are being rewarded.[44]

For knowledge to be flexible across different (and in new) situations and domains, it must be learned under varying conditions and in periods of mixed rather than blocked instruction.[45] Doug Rohrer and Kelli Taylor find that math students who practice problems blocked by type perform worse than those that practice a mixed sample of problems covering multiple previous lessons.[46] Research focused on naval air defense simulations similarly found that practice variability enhances the transferability of training.[47] Lastly, excessive hint-giving (e.g., your proverbial "foot stompers") may improve immediate performance, but it undermines long-term progress. Training without hints is slower and more error-ridden, but it is more conducive to long-term learning, since attempts at information retrieval prime the brain for subsequent learning.[48]

As we proceed in our quest to enhance the intellectual agility and preparedness of our warfighters, we must be willing to adapt *all* our educational efforts and adopt more active learning approaches that nurture enthusiasm and an appetite for lifelong learning. We have discussed some of the fundamental changes we need to make concerning how we teach. Implementing them, however, will require equally fundamental changes in how we administer. Educational progress oftentimes is not quantitatively measurable, and our organizations' traditional bureaucratic desire to control, measure, and levy additional requirements can tend to dampen enthusiasm. At a recent appearance at the Brookings Institute, Gen Berger advised, "If you are comfortable with the rate of change now, you are moving too slow."[49] Change of course is never easy, but it is high time we embrace it so that we have the leaders we need to compete and sustain our competitive advantage.

Notes

1. Joint Chiefs of Staff, *Developing Today's Joint Officers for Tomorrow's Ways of War: The Joint Chiefs of Staff Vision and Guidance for Profes-*

sional Military Education & Talent Management, (Washington, DC: 2020).

2. Department of Defense, *Summary of the 2018 National Defense Strategy of the United States of America: Sharpening the American Military's Competitive Edge*, (Washington, DC: 2018).

3. Diana Stancy Correll, "Navy Aims to Reduce End Strength, Cut Higher Education Funding in New Budget Request," *Navy Times,* (May 2021), available at https://www.navytimes.com.

4. For example, see the Flexner Report, or Bulletin Number Four, from the Carnegie Foundation for the Advancement of Teaching, and Gordon and Howell's Higher Education for Business, which was financed by the Ford Foundation. Augier and March discuss both reports, their effects on the medical and business communities, respectively, and on education and society more broadly, as well as the links between them. Mie Augier and James G. March, *The Roots, Rituals, and Rhetorics of Change: North American Business Schools After the Second World War*, (Stanford, CA: Stanford University Press, 2011).

5. David Kohnen, "Charting a New Course: The Knox-Pye-King Board and Naval Professional Education, 1919–1923," N*aval War College Review*, (Newport, RI: Naval War College, June 2018).

6. Commandant of the Marine Corps to Command General, Marine Corps Combat Development Command, "Training and Education," October 10, 1988, located in the Alfred M. Gray Collection, Box List Part 2, Box 6, Folder 12, Brigadier General Edwin H. Simmons Center for Marine Corps History, Quantico, VA.

7. Unfortunately, *Education for Seapower Strategy 2020* lacks explicit discussion of such intellectual foundations and designs and, one could argue, instead reads a bit more like a "Plan of Actions & Milestones" than a strategy.

8. *Developing Today's Joint Officers for Tomorrow's Ways of War.*

9. Ibid.

10. John C. Scharfen, "Tactics and Theory of Maneuver Warfare: Interview with Major General Alfred M. Gray, Jr.," in MCI Course 8014A.

11. *Summary of the 2018 National Defense Strategy of the United States of America*.

12. Problem solving, of course, does not mean simply solving known or even existing problems. Thinking through and framing "wicked" and ill-structured situations is also essential.

13. Michael Duncan Wyly, "Teaching Maneuver Warfare," in *Maneuver Warfare: An Anthology*, eds. Richard D. Hooker and John R. Galvin, (New York, NY: Presidio Press, 1993).

14. For example, Nobel Laureate Herb Simon cautioned, "What we must avoid above all is designing technologically sophisticated hammers and then wandering around to find nails that we can hit with them." Herbert A. Simon, "What We Know About Learning," *Journal of Engineering Education,* (Washington, DC: American Society for Engineering Education, October 1998).

15. "Tactics and Theory of Maneuver Warfare."

16. Herbert A. Simon, "Problem Solving and Education," in *Issues in Teaching and Research*, eds. D.T. Tuma and F. Reif, (Hillsdale, NJ: Lawrence Erlbaum Associates, 1980). Adler suggests some of these include critical reading, attentive listening, precise speech, and reflective thought. Mortimer J. Adler, *Reforming Education: The Opening of the American Mind*, (New York, NY: Collier Books, 1977).

17. Headquarters Marine Corps, *FMFM 1, Warfighting, (*Washington, DC: 1989).

18. Gen David H. Berger, *38th Commandant's Planning Guidance*, (Washington, DC: July 2019). Our use of Adler is no coincidence, as his thoughts on education influenced those of Col Wyly and Gen Gray.

19. *Reforming Education*. Adler explains, "The doctrinal teaching of disciples enables them to learn what the master thinks. The dialectical teaching of students enables them to think for themselves. I would go further and say the doctrinal method indoctrinates, and only the dialectical method teaches."

20. Ibid. Adler further argues that teaching should be primarily inductive and dialectical, and lectures and textbooks should be frowned upon, since teaching by the dialectical approach, or Socratic Method, which puts questions before answers, "is the only way to avoid the substitution of verbal memory for intellectual habit."

21. "Teaching Maneuver Warfare."

22. Paul K. Van Riper, "The Relevance of History to the Military Profession: An American Marine's View," in *The Past as Prologue: The Importance of History to the Military Profession*, eds. Williamson Murray and Richard Hart Sinreich, (New York, NY: Cambridge University Press, 2006).

23. For more on improving reading skills, see William F. Mullen, III, "Advanced Reading Skills: Techniques to Getting Started," *Marine Corps Gazette Blog,* (April 2019), available at https://mca-marines.org.

24. "Teaching Maneuver Warfare."

25. "Training and Education."

26. *38th Commandant's Planning Guidance.* The Joint Chiefs subsequently reiterated the importance of active and experiential learning to developing critical thinking skills. See also *Developing Today's Joint Officers*.

27. "Problem Solving and Education."

28. Herbert A. Simon, "Background of Decision Making," *Naval War College Review*, (Newport, RI: Naval War College, 1957).

29. Ibid; "Problem Solving and Education," and; Fernand Gobet, "Chunking Models of Expertise: Implications for Education," *Applied Cognitive Psychology*, (Hoboken, NJ: Wiley, March 2005); Daniella Laureiro-Martínez and Stefano Brusoni, "Cognitive Flexibility and Adaptive Decision-Making: Evidence From a Laboratory Study of Expert Decision Makers," *Strategic Management Journal,* (Hoboken, NJ: Wiley, April 2018); and David Epstein, *Range: Why Generalists Triumph in a Specialized World*, (New York, NY: Riverhead Books, 2019). Nobel Laureate Daniel Kahneman and Gary Klein refer to experts' ability to draw upon a "repertoire of patterns" to identify, evaluate, and modify (or discard and move to the next one) courses of action as the "recognition-primed decision strategy." This takes advantage of the experts' tacit knowledge. Daniel Kahneman and Gary Klein, "Conditions for Intuitive Expertise: A Failure to Disagree," *American Psychologist*, (Washington, DC: American Psychological Association, September 2009).

30. "Problem Solving and Education"; "Conditions for Intuitive Expertise"; and Sae Schatz, et al., "Making Good Instructors Great: USMC Cognitive Readiness and Instructor Professionalization Initiatives," (paper, Interservice/Industry Training, Simulation, and Education Conference, 2012).

31. Williamson Murray, "Thinking About Innovation," *Naval War College Review,* (Newport, RI: Naval War College, Spring 2001).

32. James G. March, L.S. Sproull, and M. Tamuz, "Learning From Samples of One Or Fewer," *Quality and Safety in Health Care*, (London: BMJ, 2003). March, Sproull, and Tamuz observe how organizations can overcome this conundrum: "Organizations expand their comprehension of history by making experience rich, by considering multiple interpretations of experience, by using experience to discover and modify their preferences, and by simulating near-events and hypothetical histories." Here, we focus on facilitating individual learning.

33. Similarly, Simon notes that people do not learn to ride bikes by having the principles explained to them, but rather by actually going out and riding them. "Problem Solving and Education."

34. "Teaching Maneuver Warfare." Wyly suggests that determining whether the student is developing judgment can be done by assessing the rationale for his decision. This, however, is only discussed after the student commits to a decision and the teacher tests the strength of his conviction.

35. Ibid.

36. Simon explains, "You can do anything you like in the classroom or elsewhere—you can stand on your head—it doesn't make a whit of difference unless it causes a change in behavior of your students. Learning takes place in the minds of students and nowhere else, and the effectiveness of teachers lies in what they can induce students to do." Herbert A. Simon, "What We Know About Learning," *Journal of Engineering Education*, (Washington, DC: American Society for Engineering Education, October 1998). Adler adds that "the principal cause of learning is activity on the part of the learner engaged in the process of discovery; when instruction occurs, the teacher is at best only an instrumental cause operating to guide or facilitate the process of discovery on the part of the learner." See also *Reforming Education.*

37. "Teaching Maneuver Warfare." Wyly further explains, "If we are indeed interested in teaching soldiers and Marines to think, then let's not tell them 'Here is what you are to get out of studying this battle.' That equates to 'Here is what I want you to think.'"

38. Louis Deslauriers, Logan S. McCarty, Kelly Miller, Kristina Callaghan, and Greg Kestin, "Measuring Actual Learning Versus Feeling of Learning in Response to Being Actively Engaged in the Classroom," *Proceedings of the National Academy of Sciences of the United States of America*, (August 2019), available at https://www.pnas.org. Additionally, Sternberg and Grigorenko have developed a framework for teaching for "successful intelligence," which alternates the use of multiple teaching styles (e.g., analytical, creative, and practical teaching and assessment). Doing so helps students identify their strengths and correct or compensate for weaknesses. Students taught in this manner outperform students taught using traditional methods (even on tests based on purely factual memory), and even more importantly, it connects with more students' abilities, thus fostering more intrinsic motivation. Unfortunately, most teachers are reluctant to engage in this type of balanced teaching because they have identified that they excel at one over the others and also do not want to change or deviate from their already prepared lectures. Robert J. Sternberg and Elena L. Grigorenko, "Teaching for Successful Intelligence: Principles, Procedures, and Practices," *Journal for the Education of the Gifted*, (Thousand Oaks, CA: SAGE Publishing 2003).

39. "Teaching for Successful Intelligence." Teachers must also be able to present "perceptual chunks," or components of curriculum, in the correct size and level of difficulty, as well as in the correct order, to help students digest them and more readily be able to retrieve them at a later date. See "Chunking Models of Expertise."

40. *Reforming Education.*

41. *38th Commandant's Planning Guidance.*

42. In addition to the ones mentioned here, recent trends in civilian higher education feature a variety of certificate and short courses and executive and online programs. In short, civilian institutions have developed a plethora of options adaptable to fit the work schedules, lifestyle demands, and needs of their potential clientele. This also provides the student a variety of options for identifying the learning approaches that work best for him or her. Students can experiment, so they can find the best subject material and program "match," which is most likely to generate and maintain enthusiasm for a lifetime of learning.

43. *Range*. For more on chunking, see Herbert A. Simon, "How Big Is a Chunk," *Science*, (Washington, DC: American Association for the Advancement of Science February 1974); and "Chunking Models of Expertise."

44. Barry Schwartz, "Reinforcement-Induced Behavioral Stereotypy: How Not to Teach People to Discover Rules," *Journal of Experimental Psychology*, (Washington, DC: American Psychological Association1982).

45. *Range.*

46. Doug Rohrer and Kelli Taylor, "The Shuffling of Mathematics Problems Improves Learning," *Instructional Science*, (New York, NY: Springer, 2007). Rohrer and Taylor also find that spacing practice problems across multiple sessions is superior to loading them into a single session.

47. Courtney L. Holladay and Miguel Quiñones, "Practice Variability and Transfer of Training: The Role of Self-Efficacy Generality," *Journal of Applied Psychology,* (Washington, DC: American Psychological Association, January 2004). Richland, et al. also find that interleaving sets of information rather than teaching them in blocks leads to a greater ability to generalize across contexts. Bjork and Bjork find similar results and also find that changing the environmental context when material is restudied and increasing the period between when something is studied and tested also prove beneficial to long-term learning and knowledge transferability. Lindsey E. Richland, Robert A. Bjork, Jason R. Finley, and Marcia C. Linn, "Linking Cognitive Science to Education: Generation and Interleaving Effects," *Proceedings of the Annual Meeting of the Cognitive Science Society*, (2005), available at https://escholarship.org/; and Robert A. Bjork and Elizabeth L. Bjork, "Forgetting As the Friend of Learning: Implications for Teaching and Self-Regulating Learning," *Advances in Physiology,* (Amsterdam: Elsevier, 2019).

48. *Range.*

49. Brookings Institute, "The Marine Corps and the Future of Warfare," YouTube video, 1:01:02, (May 2021), available at https://www.youtube.com.