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Steven A. Petersen, EdD
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Editor in Chief

Welcome to the April 2024 edition of the *Journal of Military Learning* (*JML*). I am the new, and fourth, editor of the journal, and I am humbled to be trusted with its stewardship for the next three years. I want to thank Dr. Keith Beurskens for his leadership while serving as the previous editor. Keith took over as editor in October 2020 while Army University was figuring out the way to forge ahead during the tumultuous era of the COVID-19 pandemic. He has done an outstanding job maintaining the journal's excellent reputation as a high-quality resource for both civilian and military training and education professionals.

In addition to the timely and relevant topics covered in the manuscripts submitted by our esteemed colleagues, this edition of *JML* includes the 2023 Army University Research Program annual report. I hope you enjoy this selection of articles and I encourage all our readers to submit manuscripts for publication consideration.

I would also like to bring your attention to the conference list at the end of this issue and note the Army University Learning Symposium scheduled for 24–28 June 2024. The symposium theme is "Artificial Intelligence Applications for Learning." The event will be conducted in a hybrid fashion with an in-person group at the Lewis and Clark Center, Fort Leavenworth, Kansas, and others invited to attend online.

The *JML* brings current adult-learning discussions and educational research from the military and civilian fields for continuous improvements in learning. Only through critical thinking and challenging our education paradigms can we as a learning organization fully reexamine and assess opportunities to improve our military education.

A detailed call for papers and the submission guidelines can be found at https://www.armyupress.army.mil/Journals/Journal-of-Military-Learning.

Peer Reviewed

Teaching Creative Problem-Solving

Tactics, Techniques, and Procedures

Todd T. Holm

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Abstract

In 2016, U.S. Marine Corps commandant Gen. Robert Neller called for disruptive thinkers to change the Marine Corps, to keep it relevant, and to give it an edge on the battlefield (Bacon, 2016). He lamented that creative thinkers get frustrated in a large and bureaucratic organization like the U.S. military, and that they leave because of that frustration. While that may be true, this call for disruptive thinkers operates from the position that some people are creative problem solvers and others are not. It may be true that some people are naturally better at seeing new solutions to problems, but that does not mean the average person cannot be taught to be more creative. This article explores four specific tactics that empirical research suggests leaders and educators in the military can use to promote creative problem-solving in their units.

Creativity and the military don't seem like a logical pairing. The military bases itself on rules, conformity, a command structure, and bureaucracy (Vego, 2013). Mitchell and Cahill (2005) found that U.S. Naval Academy plebes who completed a seven-week nonacademic program not only scored lower on the Kirton Adaption-Innovation Inventory than undergraduates from nonmilitary schools, but the 98 academy plebes who dropped out scored higher on that assessment than those who stayed. Those differences would seem to be concrete proof that military education, as it is delivered today, is not suited to fostering creative and innovative thinkers. Instead, it may actually drum the creativity out of the service member very early in the education continuum. At the same time, military success depends on creative problem solvers and innovators. It is incumbent upon leaders and educators in the professional military education (PME) continuum to foster an environment where innovative thinkers can thrive. To achieve that end state, leaders and educators must also teach students and subordinates practical techniques and tactics to help them become more creative thinkers and better at creative problem-solving. Creativity is part of the *art* of warfare, and Vego (2013) tells us, "A creative intellect allows commanders to surprise enemy counterparts and thus render them impotent" (p. 84). While several articles have been written about the need for critical and creative thinkers (Andre, 2017; Bialos, 2017; Bryant & Henderson, 2019; Ewy, 2018; Furtado, 2017; Murray, 1996/2003; Wong & Gerras, 2013), few focus on how to teach and foster creativity. This article provides four pragmatic approaches that draw from empirical research to teach and foster creative thinkers, which can be used by educators and leaders across the PME continuum.

Box, Box Adjacent, and Outside-the-Box Thinking

Before people can think outside the box, they need to understand the box. A key component of creative thinking is domain knowledge. Domain knowledge is what makes a person a subject-matter expert; it is "a well from which ideas are drawn" (Cropley, 2006, p. 395). A logistician can design a new type of container for transporting bundles of goods, but unless they also understand the types of materials, delivery routes, delivery vehicles, and a dozen other critical aspects of getting supplies from point A to point B, they are unlikely to develop a creative solution that will actually work. Learning the box is important. There is a particular body of information a person must master to be an expert in a field. It includes everything from terminology to modality variations. During the industrial revolution, a leader or a manager was expected to know *the one best way* for work to be conducted. This meant managers took all the information they could find and determined the best equipment, people, materials, and processes to complete a task with the greatest efficiency. This process is called convergent thinking. Convergent thinking is "deriving the single best (or correct) answer to a clearly defined question. It emphasizes speed, accuracy, logic, and the like and focuses on recognizing the familiar, reapplying set techniques, and accumulating information" (Cropley, 2006, p. 391). Convergent thinking is taking all the information available and coming up with *the* answer.

Creative problem-solving focuses more on divergent thinking. Divergent thinking is when a person takes all the available information and looks for all the possibilities, whether they are efficient, reasonable, achievable, or not.

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Divergent thinking is an important measurable component of creativity" (Moore et al., 2009, p. 267). However, even back in 1967, Guilford clearly stated divergent thinking is not equal to creativity. Both convergent and divergent thought require a level of mastery of domain knowledge. Marine Corps Doctrinal Publication 1, *Warfighting* (U.S. Marine Corps, 1991), establishes the need for domain knowledge to generate creative solutions when it says, "The art of war requires the intuitive ability to grasp the essence of a unique military situation and the creative ability to devise a practical solution" (p. 18). Before someone can think outside the box, they need to understand what is in the box.

Divergent thinking and creative thinking are terms that are similar in use, but they are not identical. Divergent thinking could be considered a required subset of creative problem-solving. When Ludwig von Bertalanffy, a theoretical biologist, developed general systems theory, he had only biological entities in mind. He took everything he knew about biological organisms and developed this theory to explain the operation of those organisms. That was convergent thinking. However, people outside his discipline became aware of his theory and realized it could also be applied to fields like business, education, psychology, and sociology. Cross-application to other fields of study is only possible if people with domain knowledge in a specific field seek theoretical tools and approaches from other areas to provide fresh insight to their own domains. To ask intelligent questions about a domain that lead to creative solutions, a person must first understand the domain. Then, they can capitalize on ideas outside the domain to give new and innovative approaches. To do this, they must shift from convergent thinking to divergent thinking.

Creative Solutions

For something to be considered creative, it must be original, appropriate, useful, and actionable (Amabile, 1998). Originality, however, is difficult to define. Man did not invent fire (lightning strikes or volcanoes probably did), but man did invent original ways to start fires. Everything from rubbing sticks together to modern lighters that use lasers represents a creative new way to start fires. Someone probably did invent the wheel. It was an idea no doubt derived by noticing the mechanical advantage of a log rolling. But the wheel was improved upon by creative thinkers. Their ideas are derivative of the original design but still original to some extent. The gear is derivative of the wheel, but most would consider it original. Adding a coffee maker to a car would be original; at least it was in 1959 when Volkswagen offered it as an option in the Beetle (Fernandez, 2021). Even though the car and the coffee maker were both existing inventions, it is considered original. Originality can take many forms, from something never conceived to a new use for existing items. Creativity, originality, and divergent thinking are very closely related.

While some people might have a natural propensity for creative thought, all people can be taught to be more creative. There is an abundant body of literature on leadership. One of the perennial questions about leaders is whether people are born great leaders or if situations create great leaders. Countless college essays have been written trying to answer that question. A similar question exists about creativity. Some believe that while certain people have a natural aptitude for leadership, leadership can also be formulaic and, therefore, teachable. However, while leadership classes are widely accepted, attempts to teach creative problem-solving are met with resistance. "Unfortunately, even though creativity is crucial to business and management success, higher education generally does not devote sufficient attention to it" (Lewis & Elaver, 2014, p. 236). The PME continuum can fill that gap by teaching/encouraging service members to be creative, find creative solutions, and take risks.

Risky Business

Creative solutions come with an inherent amount of risk. By their very nature, creative solutions have not been tried before (at least not in this specific context) which means they have not been proven successful, and they could fail. Creative thinkers must be risk takers. But there is also risk for those who lead the creative thinkers. A college senior named Dick Fosbury revolutionized the high jump in track and field competitions by trying a unique approach that could have made him look foolish. For three years his coaches convinced him to stick with the traditional straddle jump approach where the jumper ran up to the bar and threw themselves over by first throwing the right leg over the bar, then briefly straddling the bar in midair before bringing the left leg over. Fosbury wanted to try a different approach. It was not "new," but it was rarely used. His senior year, he came out strong using what eventually became known as the Fosbury flop. Fosbury ran up to the bar, turned his back to the bar, and went over it back first, pulling his legs over the bar, and landing on the foam on his back (Minshull, 2018). The Fosbury flop could have been a colossal flop. Because he and his coaches were willing to take the risk, Fosbury was able to take the gold in the 1968 Olympics and set a world record. Within 10 years, all Olympic high jumpers were using Fosbury's approach (Minshull, 2018).

Creative solutions aren't just risky for the person who proposes them; they are also risky for the people who approve them. Most people answer to someone at some point, and someone must be willing to take the risk of trying something new and untested. Whether that is the Fosbury flop, vertical envelopment, or drone swarms, there are risks, and someone must be willing to accept those risks. Leaders of creative thinkers often want the security of a time-tested and proven solution and are not willing to risk failure with a new *creative* approach. Shapira (1995) claims an organization's disposition toward risk tremendously influences members' creative actions and innovation.

Getting creative solutions requires accepting risk as part of the total package. Because of this, a zero-defect mentality is the enemy of creative problem solvers.

Leading Creative Thinkers

Creativity must be cultivated so it is available when needed. Leaders of creative thinkers must actively seek out ways to foster creative thought. Leaders need to welcome creative inputs by providing opportunities for creative thinkers to exercise that ability. Leaders must encourage creativity by acknowledging the ideas and not criticizing them even if they aren't the perfect solution. Criticism and even evaluation of creative solutions in the developmental stages can shut down lines of inquiry and idea progressions. Finally, leaders must reward creative thinkers. While it would be nice to be able to throw cash, cars, and prizes at them, unfortunately, that is not how the military works. However, the rewards for creative solutions (even those that do not come to fruition) can be far simpler and more personal. Acknowledging the effort, recognizing the creativity, and publicly praising the idea will go a long way toward fostering an environment where people feel able to flex their creative capabilities.

Some studies suggest that humans are born creative, but eventually, they have it drummed out of them. Land and Jarman (1992), in their book *Breakpoint and Beyond*, report the findings of "divergent creative thinking" (p. 153) tests given to 1,600 children in Head Start programs. They found that 98% of Head Start children scored in the genius category (for divergent/creative thinkers). When these same students were retested five years later, that number had dropped to 32%. Another five years later and only 10% tested at the genius level. When the same tests were given to 200,000 adults over the age of 25, only 2% scored at the genius level (Land & Jarman, 1992). Years of schooling focused on convergent thinking and trying to find the one right answer encourages students to default to convergent thinking. Military members toil under an even heavier load. "The main obstacles to military creativity are posed by the military's inherent hierarchical command structure—an authoritarian, bureaucratized system—and its thinking" (Vego, 2013, p. 84). For members of the military to be creative thinkers, they need to persist through years of formal education focused on convergent thinking and years in an organization filled with obstacles for creative thinkers. This is why Gen. Neller observed, "Most people with good ideas are annoying because they are frustrated … They get frustrated, they get tired of beating their head against the wall. [They say] 'You guys won't listen to me, I'm outta here. I'm going to go to college and make a million bucks.' And they do" (Bacon, 2016).

The good news is, if training causes the proclivity for convergent thinking, it is reasonable to assume that training can help regain divergent/creative thinking abilities. "Generativity Theory suggests, among other things, that creative potential in individuals is universal and perhaps limitless" (Epstein et al., 2008, p. 7). Cultivating creativity is a continuous process. A person cannot just get people to be creative once and then claim to have established a creative culture. Creativity needs to be integrated into the organization and continually cultivated. All branches of the U.S. military offer essay contests that focus on finding creative or innovative solutions to existing problems. These are institutional signs that creativity is valued. Less formal competition can also promote creativity within a person's command. Holiday door decorating contests are not only good for morale, but they also get creative juices flowing and publicly recognize creativity. Getting creative with fitness is another way to foster creativity, as are chili cook-offs, cupcake contests, Rube Goldberg machines, and unit T-shirt design contests. Competitions like these encourage and reward creative thinkers. To cultivate a culture of creative thinking, leaders must make creative thinking an active part of what their unit does regularly.

Teaching Creative Problem-Solving

Some argue creativity and innovativeness cannot be taught (Gow, 2014). Maybe creativity cannot be taught the way mathematics or chemistry is taught, but educators can develop lessons and assignments that promote creativity. Some researchers have gone so far as to say, "creativity training should be part of the critical thinking skills" (Schlee & Harich, 2014, p. 134). Creativity is not a linear progression of thoughts that can be prescribed in a formula, but it is teachable. "As long as we cleave only to traditional pedagogies and courses of study that leave little or no room for new experiences, we will not find the time or space necessary for nurturing the act of creativity" (Livingston, 2010, p. 59). Traditional pedagogies tend to assess convergent thinking. If PME instructors are going to promote creative and divergent thought, they cannot continue teaching via lecture and assessing by looking for the one right answer.

Many have talked about creativity like it was a light within people that just needs to be let out. To some extent, that metaphor holds. Educators and leaders should have the tools to give students and subordinates tips, techniques, and procedures to develop creative solutions. Gregory et al. (2013) clearly state, "Creative thinking can and should be taught" (p. 43). However, the pragmatic means by which instructors and leaders teach people tactics to employ to be creative thinkers are rarely discussed. Here are four specific approaches to helping people become creative problem solvers.

Failure Fixation

It is easy to get locked into one approach to solving a problem, even if it has repeatedly proven unsuccessful. This is sometimes referred to as the *sunk cost fallacy*. People will keep trying to fix, tweak, and modify a system when they should just throw it out and start fresh. There is an urban myth that perfectly illustrates this problem. As the story goes, NASA spent a decade and millions of taxpayer dollars developing a pen that would write in the weightless vacuum of space. The Russian space program solved the same problem by using a pencil (Reuters Fact Check, 2021). The story is not true, but it perfectly demonstrates how people can reasonably lock into one approach and be blind to other options. As a sidebar: a pen to write in space (and underwater and at extreme temperatures) was developed by the Fisher Pen Company in the 1960s, it was not funded by the government, and it was used by both U.S. and Soviet astronauts (Reuters Fact Check, 2021).

Today's militaries are in a technological arms race that allows for near-constant sensing and surveilling, but not everyone is quick to jump on the "big brother"-like technological trend. Many have concerns about safety and misuse. However, law enforcement jumped on the technology and crowdsourcing bandwagon with great success. Following the Boston Marathon bombing in 2013, the FBI crowdsourced the search through thousands of photos and videos of the event to track down the perpetrators. Currently, the New York Police Department is crowdsourcing the policing of people who break their "idling laws." New York City has a problem with vehicles idling and causing air pollution, so it passed a law saying vehicles could not sit and idle for more than three minutes. Unfortunately, policing that law was time intensive, so they developed a program where civilians could video record a vehicle idling for more than three minutes and post it to a city web site. If the vehicle is ticketed, then the person who turned them in would get 25% of the ticket cost, which was usually between $87.50 and $500 (Palmer, 2019). The program was so successful the city is trying a similar program for parking problems (Rahmanan, 2022). The takeaway is the New York Police Department didn't fixate on a lack of officers to police every idling vehicle; they found a new and creative approach.

Our world is constantly changing, facing new challenges, and finding new solutions. One of the greatest problems facing this generation is finding environmentally friendly power generation and storage. The world is dependent on electricity; consequently, the generation and storage of electrical energy are of paramount concern. Electricity is generated by coal plants, nuclear plants, petroleum plants, solar panels, wind farms, and hydroelectric dams (and others). Recently, the ability to store electricity has become even more important to us. Solar and wind generators are dependent on the weather. Nuclear and coal plants can produce around the clock, but each has its own environmental impact. Scientists are seeking ways to store the energy produced during peaks for use during production lows. Perhaps the most common method of storing electrical energy is by converting it to the chemical energy stored in common batteries comprised of environmentally harmful heavy metals like nickel, manganese, and cobalt. But recently, scientists started to look at more basic ways of storing energy. Pumped hydroelectric energy storage is based on the gravitational potential energy of water to generate power (Office of Energy Efficiency & Renewable Energy, n.d.). When solar panels or wind generators produce more energy than needed, the surplus energy is used to pump water from a lower elevation to a higher one. Then, when needed, the water is released to produce hydroelectric power. Essentially, a lake or reservoir becomes a battery. If scientists continued to only look for ways to make batteries that are dependent on chemical storage, they never would have found this more environmentally friendly battery. Rather than becoming fixated on one way to store energy, they looked for something completely new.

Perspective Shifting

Seeing issues from another person's perspective is helpful in solving interpersonal problems, but shifting perspective is also an excellent way to find creative solutions to problems. Looking at a problem from a different perspective can yield insights and approaches that would not otherwise be considered. Finding creative solutions often requires input from multiple perspectives and an open discussion about those ways of seeing the situation. That is one of the reasons diversity is beneficial in problem-solving groups (Reynolds & Lewis, 2017).

There are obvious weaknesses and problems associated with bringing together a group of people from diverse backgrounds to work on a problem. There will be conflicts about how to approach the problem, what a successful solution entails, and how the group should proceed. Therefore, it makes sense to bring together like-minded people to solve problems. Not surprisingly, like-minded groups are not as successful at problem-solving because they tend to see the problem similarly (Scheible, 2017). More specifically, Hemlin et al. (2008) found "groups including members from different cultural or disciplinary backgrounds tend to be more creative than those whose members share a more homogeneous background" (p. 205). Seeing a problem from multiple perspectives is a real asset when a group is trying to find a new and creative solution.

Shifting perspectives is similar to using analogies or metaphors to see problems from a new perspective. Businesses "often participate in workshops that enhance the metaphorical or analogical thinking of their employees" (Schlee & Harich, 2014, p. 135). These exercises promote creative problem-solving by taking new perspectives. For example, if a group was looking for a better way to insulate against cold weather or winds, they might look closely at the flora and fauna of the area to see how it has evolved to thrive in the harsh environment. Birds provide insight into nature's best insulating practices. A bird has outer feathers that are rigid and create a solid barrier between the animal's body and the harsh climate. Between the outer feathers and their skin is a layer of lighter "fluffier" feathers that create pockets of air. These air pockets prevent the transfer of heat away from the body. Builders in harsh climates have learned if the north side of a building is a solid barrier (no windows or door and wrapped in construction wrap) and a storage room of "dead air" is created inside the building, the heat stays in, and cold stays out. Using the feathering of a bird as an analogy for building construction results in a more energy-efficient building.

For military problem solvers in the twenty-first century, the solution to most problems is often a new technology, which has quickly led to technology dependence. When technology stops working, people are often left staring blankly at a nonfunctioning piece of tech, trying to figure out how to get a different piece of tech to do what the first one did. When operating in an antiaccess/area denial situation, it can be helpful to shift perspectives by thinking about how George Washington would have handled the problem. Wars were waged long before modern technology changed the face of war. Antiaccess/area denial threatens to send troops back to those earlier days in some regards. Unless warriors are prepared for those situations they will be at a disadvantage.

But many of these problems cannot be solved by an in-stride battlefield change. If satellite navigation is disrupted, the solution is not to just say, "We will navigate by the stars the way Magellan did." While the approach is valid, it will not work unless someone in the group has been trained in celestial navigation. That is one of the reasons the U.S. Naval Academy reinstated briefing lessons on celestial navigation in 2015 (Prudente, 2015). Chance favors the prepared mind. Being able to see problems through the lens of Washington does little good if the skills Washington and his contemporaries used have been lost to the ages.

Channeling your inner Washington or your inner Genghis Khan is only helpful if you have a solid understanding of how they operated, lived, and thought. Avid students of history have many iconic leaders from whom to choose when they get ready to see things from a new (old) perspective. Fortunately, you don't need to be a history scholar to use the technique. The key is to see the problem from a new perspective or with a fresh outlook, thereby seeing new solutions. An old idea in a new situation can be just the creative solution needed.

Repurposing Assets

The character MacGyver was the king of repurposed assets. With duct tape, a paperclip, and some innocuous third item, he could pick a lock, make a hang glider, disrupt satellite communication, or create a bomb. His particular genius was a combination of elemental thinking and repurposing assets. While his repurposing was clever, creative, and even funny, repurposing assets in times of war can be very serious business. While improvised explosive devices might not be thought of as repurposed assets, that is exactly what they are. Multiple acts of domestic terrorism have been committed with repurposed fertilizer. Automobiles have become explosive delivery devices. Improvised explosive devices became the leading cause of U.S. casualties in Operations Iraqi Freedom and Enduring Freedom (Niedziocha, 2013). Asymmetric warfare leads forces to use what they have as what they need. That is the essence of repurposing assets as a creative problem-solving technique.

Asymmetric warfare is rife with examples of the smaller forces finding unconventional and creative ways of disrupting and sabotaging large enemy forces. During World War II, the French Resistance used explosives to damage bridges and railroads in occupied territories. But explosives were hard to come by even though the Allied forces airdropped tons of explosives to the Resistance. Eventually, the French started making their own explosives in secret laboratories in apartments and homes. Ultimately, they realized removing the bolts from the tracks of the railroads on a bridge was just as effective as dynamiting the bridge. They had wrenches used in construction and repair shops. They simply repurposed them as tools of war.

Most martial arts weapons were originally farm implements. In the 1400s, Okinawa's three warring parties were united into the Ryuku Kingdom, and King Shō Shin passed a law forbidding Okinawans from possessing weapons. The Mountain Academy of Martial Arts (2021) website explains that the Kama was originally a scythe-like tool used for harvesting grains and rice, and the tofu was either a weapon disguised as the crank handle on a grindstone, or the crank handle on a grindstone was turned into a weapon. These are just small examples of turning what is available into what is needed.

Delta Course of Action

In the PME environment, it is not uncommon for instructors to pose a problem to a group and ask for three courses of action (COA) to resolve it. These are often referred to as Alpha COA, Bravo COA, and Charlie COA. One idea is to simply ask for a fourth COA, Delta COA. Delta COA is the expressed creative problem-solving COA. It should feature a creative or risky approach that could conceivably solve the problem. It needs to solve the problem (or perhaps reframe the problem) through unconventional means. The Delta COA assumes that the first three COAs failed or were not possible. This approach codifies and normalizes creative problem-solving.

The idea of a Delta COA helps institutionalize creative problem-solving. It makes creative problem-solving a well-traveled path when seeking solutions. This is instrumental to success in creative problem-solving because the institutional environment plays an important role in shaping creative activities (Ford, 1996). As

Vego (2013) points out, a significant problem with introducing creative thinking in the military is that military thinking "is exemplified by conformity, groupthink, parochialism, dogmatism, intolerance, and anti-intellectualism" (p. 84). Institutions, including schools and the military, have pushed convergent thinking and slowly eroded the propensity for divergent thinking, and the result is it slowly disenfranchised the creative thinkers. It will take more than a couple of attempts to bring forth creativity regularly. To make creative problem-solving a readily accessible skill, it must be something people engage in on a regular basis.

Creativity needs to be habitual. Ford (1996) summarizes the works of many researchers and concludes that even very creative people tend to fall back on uncreative solutions in an organization that does not foster creative thinking. "These common frames of habitual thought and action narrow the range of likely behaviors an organization member will enact in familiar organizational settings" (Ford, 1996, p. 1116). Therefore, leaders and educators must seek out and enact ways to make creative problem-solving habitual. Making a habit of asking for the Delta COA is just one way of accomplishing that.

The Role of the Leader/Educator

Everyone has the ability to contribute innovative and creative solutions to problems. A combination of habit and institutional dogmatism has caused many to lose touch with their creative abilities. Therefore, it is part of the responsibility of leaders and educators to help them find their creative problem-solving skill set and drag it into the light of day where it can be used to *render our enemies impotent*. There are things educators and leaders can do to promote and foster creative problem-solving.

Suspend Judgment

Being armed with four tactical-level techniques for generating creative problem-solving ideas is only part of the solution. Those ideas must be curated and allowed to become full-fledged solutions. This requires patience, support, and good leadership. Assuming a leader has created an environment where creative thinking is welcome and even expected by employing the techniques described here, and that in doing so they have people coming forward with some outside-the-box ideas, it is incumbent upon the leader to help those ideas become a reality.

It is easy to find reasons something will not work. It might even be seen as a good way to save time and energy by rejecting ideas early in the process. But during a brainstorming session, judging the quality, validity, or even the preferability of the ideas is a surefire way to shut down idea generation and avenues of discovery. It is crucial for leaders to withhold judgment until the group has reached a natural stopping point in the brainstorming process. Only then should ideas be evaluated. This also allows ideas to branch into new ideas and generate even more possible solutions. Any blunt instrument can smash an idea, but there is an art to turning ideas into working solutions.

The Way Ahead

The ideas and approaches presented here are tools educators across the PME continuum can use to teach and foster creativity. The next logical step would be for researchers to assess the efficacy of these techniques through empirical research. Researchers could use a classic instrument like the Torrance Test of Creative Thinking (Torrance, 1974) to test students at the end of the training cycle to get pretest data. Then, in the next training cycle, instructors could implement one or more of these techniques throughout the training cycle and administer the Torrance Test to this posttest group. Comparing the pretest and posttest results of the two groups should determine the efficacy of the instructional techniques. The variable would need to be more than a one-off exercise because creativity needs to be fostered over time. Adapting these techniques to a block of training should be relatively easy.

Conclusion

Creative problem-solving is essential to the profession of arms. "The art of war requires the intuitive ability to grasp the essence of a unique military situation and the creative ability to devise a practical solution" (U.S. Marine Corps, 1991, p. 18). While Vego (2013) argues there are many factors working against being creative in the military (authoritarianism, dogmatism, hierarchy, etc.), it is imperative that officers and noncommissioned officers be autonomous, free thinkers who can tap into their creative abilities to solve problems. Therefore, it is the responsibility of educators and leaders alike to provide opportunities for the men and women of the military to flex the might of their creative minds. The PME system is an ideal place to begin fostering creative problem solvers. The four simple techniques explained in this article are just a few of the many ways to promote and foster creative thinkers.

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Fast-Tracking Student Success

Curriculum Adaptations for a Compressed Master's Thesis Program

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Abstract

The COVID-19 pandemic was a forcing function for the U.S. Army Command and General Staff College (CGSC) to reassess instruction for its master's thesis degree program. Institutional revisions realigned instruction to provide a broad overview of research activities following the outline of the research paper. Detailed instruction and resources allowed students to better focus on completing the degree within nine months. Learning activities and assessments provided just-in-time instruction and feedback to support student progress through the research design process. The CGSC timeline and program are unique among institutions of higher learning. However, there are some elements of the CGSC redesign that could benefit students in more traditional thesis programs without sacrificing quality or relieving research students from the individual effort expected to complete a thesis.

While the COVID-19 pandemic caused a great deal of disruption in academic programs worldwide, the virus was a catalyst for the U.S. Army Command and General Staff College (CGSC) to review its master's thesis degree program and associated curriculum. COVID-19 forced CGSC to transition many of its courses and lessons to a distance learning format to accommodate an unanticipated group of distance learners and to allow the continuation of instruction through quarantines of classroom groups due to a COVID-19 diagnosis. One such group of courses were those associated with the Master of Military Art and Science (MMAS) degree program. Evaluating and redesigning the courses associated with that thesis program resulted in improvements for both distance learning and resident students that could be transferable to other institutions in supporting their thesis writers.

The MMAS degree requires students to complete the 10-month Command and General Staff Officer Course curriculum and defend a thesis on an element of military art and science in the same time frame. Therefore, thesis students have around nine months to complete a thesis that is in addition to their mandatory coursework. A rigorous, compressed curriculum on a short timeline compounded an already stressful activity for many who lacked original research experience. In 2020, CGSC conducted a program review of the thesis-related curriculum and degree program to identify how to best support student success in completing a quality thesis. Issues with the program to overcome were a lack of student research experience, a compressed timeline, sporadic or virtual contact with faculty (due to COVID-19 meeting restrictions), and an already demanding graduate degree program curriculum.

Many curriculum development models begin with identifying the gap or educational problem to solve (Boyle, 2016; Department of the Army, 2018; Wiles & Bondi, 1984). In the case of the CGSC MMAS program, the most evident gap or problem was the delivery of the initial research methods course curriculum in a distributed learning modality rather than an in-person approach. Curriculum, student activities, and assessments required adjustment for a distributed learning environment where student interactions with instructors and other students were more restricted. However, gaps also existed in the curriculum content related to the skills students needed to complete a viable thesis.

Before COVID-19, the primary documents for student use in the MMAS research methods class were a syllabus and a student text (Student Text 20-10; U.S. Army Command and General Staff College, 2020) that described the outcomes of the course, assessments, and formats for the products associated with the thesis. The initial class size often exceeded 200 students. Faculty lectured from a lengthy PowerPoint presentation continuing in one class where they left off at the previous class meeting. Subject-matter experts occasionally taught individual lessons using

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their own materials. The course manager assessed student learning with a class participation grade, a summative multiple-choice examination, and the submission of an outline of the proposed research project—the prospectus. Subsequent courses in the thesis program continued thesis development and execution. These courses relied on individual faculty members to work with students in small groups or individually to finalize the proposal and conduct the thesis research. Most of the thesis writing by students occurred in the final two months of the 10-month course. The thesis committee chair assigned a summative grade to the overall quality of the paper and its oral defense by the student (U.S. Army Command and General Staff College, 2020).

Across multiple curriculum development designs, four key functions are common: identify goals or objectives, determine the best approach to meeting those goals or objectives, develop the materials to implement the approach, and evaluate the effectiveness of the instruction (Tanner & Tanner, 2007). MMAS students had to complete their theses within nine months of course start (one month before graduation to allow for review and approval of the theses) despite a lack of prior experience with thesis writing. Individual theses needed to advance the body of knowledge for military art and science. Students therefore produced a written product on a meaningful topic that could withstand professional scrutiny. As Army leaders and new researchers, students had an expectation to understand the concepts and processes of research and how to critically analyze material in their profession so that they could mentor future researchers. The foundational research methods instruction had to be in an online format to support the distributed learners within the course. However, the modifications for an online format for the research methods course also had applicability to the in-person version of the curriculum.

Identifying the Goals

The goal of the MMAS curriculum was to educate students to produce a research thesis through an online format. To accomplish this overarching goal, students would describe and apply concepts and principles related to research, use appropriate research methods, follow the ethical requirements associated with research, analyze a topic relevant to the advancement of military art and science, and defend that analysis. These subgoals became the enabling learning objectives within the MMAS curriculum (see Figure 1). The curriculum had to ensure student engagement on a regular schedule to monitor student learning. Regular meetings would also encourage student interactions with one another and with lesson content. Assessments had to align with curriculum content and be structured in a manner that promoted student learning by providing tangible products that checked student mastery of lesson content while requiring progress in research design.

Figure 1
Program Goal and Enabling Learning Objectives

Goal: Educate students to produce a thesis to expand the body of knowledge within military art and science through an online format.

Enabling Learning Objectives:

- Describe and apply concepts and principles associated with research
- Apply appropriate research methods
- Follow the ethical requirements associated with research
- Analyze a topic relevant to the advancement of military art and science
- Defend the analysis

Developing the Approach

The pre-COVID research methods course relied on providing the bulk of instruction early in the first semester by meeting twice a week in many cases. This limited the ability of students to apply what they had learned in class. Students had to compose their thesis proposals on their own time after the bulk of research methods instruction and around academic requirements for the Command and General Staff Officer Course that they also attended. Most instruction was in a large class setting delivered by lecture, providing limited opportunities for student interactions with instructors. The research methods course culminated with an examination and the prospectus submission. Although resident course students had access to library resources locally and online, the availability of those resources to distance learners would not be equal or even guaranteed. The online approach would restrict student interactions to reinforce learning or address thesis design concerns in the absence of regular face-to-face access to other students and to faculty. Course activities had to provide meaningful interaction between learners (Moore & Kearsley, 1996)—a necessary component within adult learning theory (Merriam & Bierema, 2014).

Therefore, the initial research methods course needed to provide more opportunities for learner interaction. The curriculum schedule required space between lessons to allow distance learners time to find resources, including remotely accessing faculty members in a different time zone for guidance. Few students would start the course with experience in research paper development, so lessons and learner activities would need to move the student progressively through the development, design, and execution of a research project. The research methods course was scheduled deliberately around Command and General Staff Officer Course classes to help students deconflict their research activities with other academic requirements. Ultimately, students would end the initial research methods course with a viable research proposal and requisite knowledge to execute the research project to make the most use of the four months for the course. Furthermore, students needed to recognize that the course design would help them attain their research goals (Moore & Kearsley, 1996).

Learner activities within the curriculum required authentic learning experiences that progressed the research plan development while reinforcing individual lessons (Boyle, 2016; Merriam & Bierema, 2014). Students needed less emphasis on how to write—a skill for graduate students assumed by the institution—and more placed on what to write and why to include that material within the research proposal. Because many students were new to the research methods content, the course redesign included recorded lessons for later viewing by students unsure of lesson content and without ready access to faculty. The Blackboard Collaborative Ultra module provided an online teaching platform with the option to record individual lessons and other instructional videos to augment classroom instruction. Lastly, instructors needed to post individual lesson assignments and assessments to the Blackboard system in a way that presented discrete waypoints through the curriculum to ensure student timely progression through the thesis development process. These discussion posts would not only reinforce learning but could also serve as an incentive for online students to continue with their research program (Shi & Xi, 2021).

The second MMAS course focused on research plan execution and thesis defense preparation. The critical requirements for this MMAS course were conducting data collection and analysis before providing a mock defense of the thesis in class. The format for the course was a small group practicum to develop the thesis defense with class sizes of more than 20 students. Student participation and learning was expected to increase with smaller class sizes that permitted more interaction with instructors and fellow students (Moore & Kearsley, 1996). The pre-COVID timing of the course required some students to present their mock defense for feedback well before their data analysis was possible. Therefore, adjustments in class size and learning activities were needed to provide opportunities for students to receive meaningful feedback on their thesis products.

The pre-COVID version of the thesis defense course provided a PowerPoint template for a thesis defense and little else in course structure. Students relied on their committee chairs rather than course content for detailed guidance resulting in some students being ill-prepared for either completing the thesis on time or successfully conducting its defense.

The final course in the MMAS sequence was the completion of the research project, the actual defense, and the submission of the final thesis for a grade. The pre-COVID course lacked a rubric for assessing the thesis components and quality. The variety of disciplines for study within the CGSC and the experiences of the faculty in their disciplines seemed to prevent the use of a common rubric. Still, the lack of detailed guidance on grading sometimes resulted in highly subjective, inflated grades and provided little actual feedback to the students. The revised courseware included a small set of detailed rubrics that would provide consistency in assessment and quality feedback to students relative to the degree program learning objectives regardless of the discipline or format of their papers.

Developing the Content and Learning Activities

Designing content begins with identifying what the learner should do or demonstrate at the end of instruction (Boyle, 2016; Department of the Army, 2018; Wiles & Bondi, 1984). Large class sizes require imagination in designing learning activities to transcend a lecture delivery of the curriculum and increase instructor-student and student-student interactions (Yang et al., 2018). Students need to demonstrate in an assessable manner that they comprehend individual lesson concepts and how to apply them to a research proposal. These assessments confirm to students that they attained the learning objectives for the course and to reassure them that they could complete a quality research project in the time remaining. More formative assessments were therefore necessary to improve learning outcomes and provide satisfaction to students on their progress in the research design process (Miknis et al., 2020).

A concern with the pre-COVID MMAS research methods course design was that the assessment of skills and knowledge occurred predominantly at the end of the course. Summative assessments of this type rarely provide substantive feedback to students on their areas for improvement because students sometimes lack an incentive to remediate their shortfalls or apply corrections to their products after the assessment (Miknis et al., 2020). Assessments at the end of the MMAS research methods course frequently resulted in students withdrawing from the thesis program when they realized too late that they had failed to master the knowledge and skills required to complete the thesis.

For the redesigned course, individual lessons needed direct formative assessment of learner actions throughout the course. Discrete assessments through the course would allow faculty to provide timely feedback and to identify struggling students soon enough to remediate learning shortfalls to keep them in the program (Boyle, 2016). Detailed rubrics would also permit student reflection on their learning and products before submission for a grade (Miknis et al., 2020).

Adult learners desire interaction with other learners during instruction (Merriam & Bierema, 2014). However, large class sizes typically preclude in-depth student interactions or prevent instructor assessment of whether individual students demonstrate competency in the lesson's content (Hamann et al., 2012; Yang et al., 2018). Blackboard allows students to post contributions as documents or online posts. The redesigned course would include reflective discussion board questions challenging students to apply lesson materials and gauge student progress in their research plan development. This approach was consistent with best practices encouraging synchronous and asynchronous interactions among students in an online setting (Snelson, 2019; Yang et al., 2018).

Research proposals generally follow a logical sequence of elements. First-time researchers frequently miss the relevance or connections between those elements. They are also anxious about conducting research and their ability to complete a research project (Earley, 2014). Lesson sequencing is on par with defining the scope of the curriculum in supporting student success (Boyle, 2016). Without the benefit of multiple semesters to provide research methods instruction before students produced a research proposal, it seemed appropriate to present the research methods course material in the same sequence as the organization of the research proposal and offer learning opportunities after lessons to apply the concepts to the developing research proposal.

The first block of lessons in the research methods course covered topic development, problem statement design, appropriate and aligned research questions, and the other elements of the first chapter of a research proposal. Discussion post requirements included appropriate activities that guided students to draft that first chapter. An important formative assessment was posting a draft problem statement and research questions, which allowed faculty to provide timely feedback to each student on the viability and alignment of those elements for a research paper.

The next set of lessons in the redesigned course covered the "Literature Review" chapter, including an orientation to college library resources, source analysis, and how to organize the literature review. For distance learners, the library resource discussion included potential resources in their communities. Students were located physically across multiple geographic areas, including overseas, so instructional content included using the CGSC's online library resources and how the CGSC could augment limited resources in other sites. Positioning the lessons after topic and research question development was expected to better focus student time in the library on what they needed for their research project rather than exploring potential topics. Discussion prompts solicited student successes and failures in using library resources and organizing their notes from those sources.

Methodology chapter lessons followed in the redesigned course. A perceived challenge to first-time researchers is the need for timely identification of an appropriate research methodology and how to implement its mechanics in a research project. In response, the new MMAS curriculum provided an overview of the principal quantitative, qualitative, and mixed method designs for research. Instructors encouraged students to use one of a few standard approaches as first time researchers. Faculty composed short, scholarly written papers for popular techniques such as microethnography and case study designs. These papers included material from salient sources for the research design so students could quickly dive deep into implementing the chosen research approach without spending significant time searching through research method texts.

An addition to the curriculum was the creation of small seminar groups of 30 or fewer students working with a terminal degree holder with experience in a particular research method for an open dialogue session. Creating smaller work groups of students engaging with faculty was expected to enhance student learning and interest in the course material (Yang et al., 2018). This seminar opportunity allowed students to ask specific questions about individual research proposals and receive detailed answers to accelerate student research method development and documentation.

The final lesson focused on research ethics. Past experiences within the CGSC indicated caution was necessary when inexperienced researchers and supervising faculty integrated material from potentially restricted sources or from human subjects. The course added discussion of operational security considerations and student completion of basic instruction on human subjects research within the Collaborative Institutional Training Initiative (CITI) program. This instruction helped avoid noncompliance with Army operational security regulations and federal policies regarding research involving human subjects. The self-paced online CITI training completed before classroom instruction permitted more focused discussion during the class lesson time on the mechanics of ethically protecting human subjects within the final thesis.

The redesigned thesis defense course in the MMAS program sequence limited student seminar groups to eight students per faculty member to allow more time for discussion and practice presentations as learning activities. Program administrators grouped students with similar topics or research methods to promote more depth to discussions and feedback to peers. The assessments in this course included a mock thesis defense, feedback to peers on their mock defenses, and a draft thesis that demonstrated the integration of course lessons learned.

The final course in the MMAS sequence remained an unscheduled practicum between the students and their committees to complete the thesis and conduct an oral defense. However, the redesigned course included rubrics for both the defense and the final paper. These rubrics provided word pictures clearly describing the criteria for individual elements expected in both deliverables (Boyle, 2016). The rubrics remained flexible to the range of potential research methodologies and disciplines that might be employed but increased the calibration of grades across assessments.

Meetings—to include the thesis defense—were permitted to be virtual to accommodate those in quarantine or trying to minimize exposure to COVID. Virtual defenses also supported the addition of subject-matter experts from outside the CGSC who might be located in a different area.

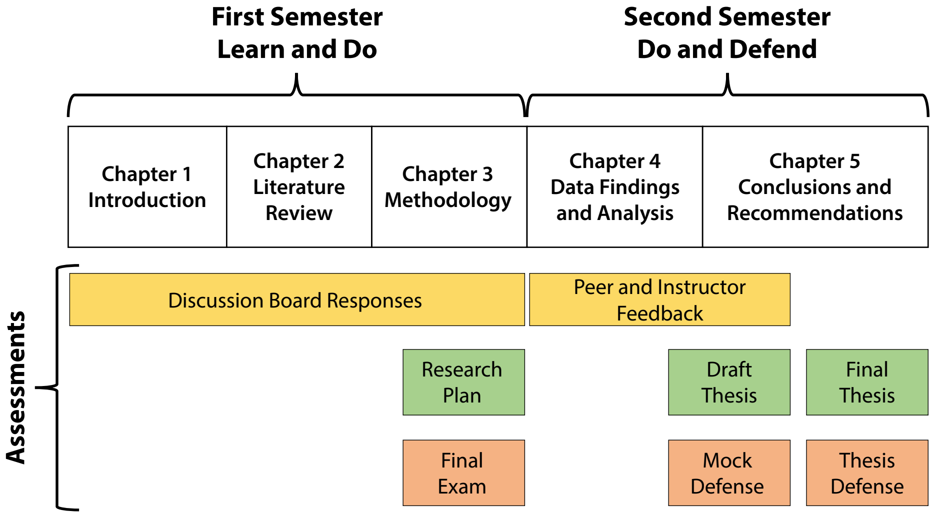
Evaluating Instruction

Assessments should assess student attainment of goals and enhance student learning as an activity within the curriculum (Boyle, 2016; Miller, 2019). The comprehensive examination at the end of the pre-COVID research methods course was consistent with the goal that learners would retain sufficient knowledge to conduct their research projects while also carrying that knowledge forward to mentor future researchers. The other original assessments did not align with the course goal to promote student learning. Classroom participation and the prospectus assessments lacked detailed rubrics to facilitate instructor grading and to permit students to anticipate assignment requirements. Checks on learning within lessons failed to test all students in their mastery of lesson material; only a few could respond within the classroom to quiz-type questions from the instructor to assess learning. Furthermore, the prospectus was more of an administrative document indicating students intended to continue with the thesis program rather than assessing individual application of learning within the course.

The prospectus assessment became the actual research proposal as a check on student learning but also as an incentive to complete a coherent research plan in a timely manner. Not all students would or could complete a detailed research plan in the time available due to the complexity or depth required for the topic. The rubric focused on whether the students used lesson content to develop the research project framework rather than on attaining a detailed, complete research plan. The intent was to encourage student effort in generating all elements of the research design while providing sufficient feedback to facilitate quick completion of a robust research proposal. Rubric word pictures with grade-associated standards for each element of the research proposal allowed students to adapt their priorities for out-of-class work efforts and reflect on their work. Timely faculty feedback allowed students to refine their research plans prior to entering the data collection phase of their projects during the second semester.

The final examination included questions from each lesson at comprehension and application levels of learning. This blend of learning levels ensured students demonstrated recall of key elements and that they could apply that knowledge to their research plans. Aligning questions to individual lessons provided a way to evaluate specific lesson content and delivery after analyzing student performance on examination questions.

Figure 2
Curriculum Design Based on the Research Paper Organization



Findings

The overall approach followed the Four-Component Instructional Design (van Merriënboer et al., 2002). The course advance sheet (syllabus) described *the learning tasks*—the course-enabling learning objectives—for student mastery from instruction. Scholarly written materials by faculty on specific research methods and small group seminars with faculty proficient in those research methods provided *supportive information* to augment lecture materials delivered in a larger group setting. Recorded lessons also were supportive as a resource for student reference after instruction. Following the outline of the five-chapter research paper in sequencing lessons provided a logical organization of the curriculum (see Figure 2) and introduced important concepts to develop the thesis in parts. This course structure with formative assessments was an example of just-in-time information delivered as the student needed it through research proposal design. Incremental development and assessment of the research proposal elements allowed students to complete *part-task practice* of what they were learning rather than tackling the entire research project at once as the pre-COVID course design favored.

Learning activities aimed at completing individual elements of the research proposal as students progressed through the program of courses. For example, the initial lessons focused on the elements of the "Introduction" chapter. A common thread in the research methods course design was the necessary alignment of the problem, research questions, and methodology. This emphasis ensured students developed viable research plans from the beginning and maintained viability as they worked through writing the thesis. Discussion board questions for the Introduction chapter lessons prompted students to share their understanding and application of the lesson material. Student interaction and feedback to each other reinforced the lesson concepts and student self-efficacy in completing the research course.

The new approach to the initial methods course leveraged some of the capabilities of the Blackboard learning management system to enhance student interactions. The Blackboard Discussion function provided the ability to conduct student dialogue asynchronously between students and faculty. The discussion board posts demonstrated faculty monitoring of student progress weekly and provided timely feedback to student ideas (Mehrotra et al., 2001) without necessitating synchronous communications. The posts also provided a necessary opportunity for learners to reflect and express what they gained from the course—a good practice in distance learning design (Chickering & Gamson, 1991; Snelson, 2019). One requirement was to post the proposed problem statement and derived research questions to socialize these elements with other students for feedback, challenging students to think critically about their products and the work of others. These postings allowed detailed instructor feedback to correct research question misalignments early in the research design process.

Scheduling the initial research methods course with only one meeting per week across the first semester spread out the curriculum to allow students more flexibility to access library resources, faculty, and other learners between meetings. The lesson schedule also allowed students to focus on discrete tasks in the incremental design of their thesis proposal before progressing to the next lesson and its associated requirements.

After initial coverage of expectations for student progress in the second semester, classroom instruction provided an overview of the defense for several reasons. New researchers expressed a fear of the defense, lacking experience with this academic requirement. Students reported they believed the thesis defense would be confrontational with their committee. Providing an example presentation helped them appreciate the design of an acceptable defense. Recording the example defense allowed students to access the material at a time of their choosing, a key element in post-COVID adult instruction (Shi & Xi, 2021). Faculty modeling the question and answers associated with the defense provided a forum to discuss the types of questions to expect and how they related to a research plan. The Blackboard system provided a vehicle to record a defense using the course slide template, an effective way to augment classroom instruction on conducting the defense (Yang et al., 2018).

The example defense demonstrated the linkages between the research plan (already developed by the students), the data collection and analysis (in progress during the second semester), and the elements to include in the final thesis draft that anticipated committee (and reader) questions. Smaller class sizes meeting in standard classrooms allowed social distancing to reduce the risk of COVID exposure. Students and faculty followed all COVID risk mitigations such as masks and antibacterial wipe downs. In some cases, seminars met virtually to accommodate individuals in quarantine from COVID. When in person, smaller group sizes permitted greater exchanges and student involvement in lessons.

To better align assessments with student learning objectives, each assessment within the revised curriculum aligned with course enabling learning objectives. Each assessment (except for the final examination) incorporated a rubric to assess discrete learning concepts and application to the research process. Grading rubrics should guide instruction and student learning as well as assess student learning. Coincidental to the publication of the rubrics were questions from students and faculty on individual rubric elements, allowing for additional discussions and calibration of expectations within the program.

The discussion post rubrics included word pictures for specific elements associated with the lesson content and application to help students understand the differences between mastery, objective attainment, and marginal performance on submitted products. These frequent discussion post responses created regular opportunities to assess student learning, which provided feedback to the instructor while also helping students gauge their progress in the course—key elements of a discussion forum (Hamann et al., 2012). Instructor feedback on poor student performance increased student interactions and depth in subsequent posts, better preparing students to complete their research plans. While students continued to drop from the program at a high rate as they had in previous years, the withdrawals occurred steadily rather than as a large group at the end of the course when students discovered they had missed key lesson concepts due to late or unstructured feedback on assessments.

Students were able to make iterative product improvement assessments after focusing discussion post prompts in the research methods course on discrete deliverables such as research question development, literature review organization, methodology selection with a justification, and data collection methods with potential areas of concern. As a result, students built their research plans as they progressed through the course while receiving feedback on their comprehension and application to their research plans. This approach ensured more frequent individual feedback through the first semester to avoid the end of semester realization that key concepts had been missed and a proposed thesis design was not viable.

Similarly, rubrics for the second and third courses in the program provided opportunities for student reflection on their work prior to submission. These rubrics calibrated faculty assessment of products and learning activities across academic disciplines. Students in the second course used the same rubric for their mock defense to provide feedback to their peers during other mock defenses; faculty used a separate rubric to assess the quality of student feedback to their peers. Sharing the mock defense rubric to provide feedback to peers provided an additional opportunity for student self-reflection and evaluation of their own products. Students and faculty reported fewer surprises in third course assessment outcomes because students had gained confidence in using the rubrics to gauge their performance prior to product submissions.

An element of instruction design is to conduct a program evaluation to assess the quality of the curriculum in addition to how well students achieved learning objectives. The MMAS curriculum designer conducted a systematic review after each course to determine where the curriculum was failing to attain learning objectives and support student success. A formal survey of students who withdrew from the MMAS program revealed that 39% of withdrawals were due to lack of time management to complete thesis requirements while simultaneously completing the Command and General Staff Officer Course curriculum. Only 26% of the respondents to the survey believed the content or difficulty of the research methods course was the cause for their withdrawal from the program. Sensing sessions with students and individual survey comments identified areas for curriculum improvement.

MMAS students included those who had completed graduate and postgraduate degree programs earlier, which provided valuable insights for courseware improvements. Some feedback contrasted best practices from other research programs with that at the CGSC. Distance learners reported struggling with accessing library materials until they were physically at Fort Leavenworth, Kansas, due to connectivity challenges, local library limitations, and a lack of detailed instruction on accessing CGSC's library. This resulted in refinement of the library research material to include remote library access and improvements in library support to nonresident students. A group of experienced faculty members also collaborated on rubric revisions to improve the existing products based on user and faculty feedback.

Moving Forward

While the initial challenge for redesigning the MMAS curriculum was to provide lesson content to distance learners, resident and distance learners used the same curriculum due to the lack of predictability during the COVID period of academic year 2020–2021. Distance learners during the initial research methods course joined their resident peers for the second and subsequent courses once the Department of Defense was able to relocate students who started as distance learners. The revisions to the curriculum to include a hybrid course design to accommodate in-person and online instruction continued past the COVID period. These changes were beneficial to students who needed flexibility in their academic schedules and for faculty reacting to the loss of large meeting areas required for the first course's classes.

Feedback from faculty and students resulted in modifications to lesson content and sequencing to better align with student needs. These modifications helped deconflict MMAS requirements with those from the remainder of the CGSC course curriculum and assessments. For example, the lesson on source identification and library use was modified to include an optional video on using the CGSC library's online search functions and resources. Classroom instruction also provided examples of other library holdings and capabilities as a future resource for distance learners without direct access to the CGSC library. Another change included scheduling MMAS lessons around peak CGSC curriculum assessments. More faculty became involved in the methodology seminars permitting smaller groups of 15 or fewer students per faculty member. Unlike the initial year of implementation, all students had their specific research method questions addressed in the seminars by the end of that lesson.

The flexibility of the course to go online or in person supported resident and distance learning students. The reorganization of the curriculum to include more timely and regular assessments using detailed rubrics also increased student confidence in the role of *researcher* to complete a quality study despite the condensed timeline. The Blackboard discussion function benefited resident course students in subsequent academic years by providing a chance to reflect, apply, and analyze lesson concepts with peers and instructors when large classroom sizes precluded dialogue by most students during the lessons.

COVID forced many institutions and instructors to redesign their curricula to support online or hybrid instruction (Guidi et al., 2023). In the case of the CGSC MMAS thesis program, the redesign drove a detailed review of the existing program's support of student learning across all modalities resulting in enduring changes to support future resident and hybrid instruction requirements. The challenges of the CGSC program resulted in several key lessons that could enhance traditional thesis programs to improve student learning and success.

The first lesson was the design of a research methods course using the individual components of the research proposal as an outline for content and sequencing. The lack of student research experience and the initial requirement for an online course drove this design. However, it proved successful for resident and nonresident students by establishing the requirements for a successful research paper and by generating frequent opportunities for feedback to students during the research plan development process. Thesis committees—especially the chairs—serve an important role in informing student research plan decisions. Providing common instruction to students on essential design topics established uniformity—especially across multiple academic disciplines and research methods.

While graduate and postgraduate research methods courses cover quantitative or qualitative designs in detail, the accelerated pace of the MMAS thesis precluded more than a survey of the designs in sufficient detail to inform a student decision on research approach. Students in traditional programs might benefit equally from the CGSC adaptations. MMAS students covered both qualitative and quantitative designs in class but relied on faculty-developed fact papers on specific research techniques to confirm student choices on methodology and to provide a detailed roadmap to using the chosen technique in their thesis. These well-written papers with liberal citations to authoritative texts permitted students to go directly to published works for greater detail on their chosen technique while remaining accountable in course assessments for general knowledge of other research design methods. Seminars for specific methods allowed students time to ask methodologists their questions on implementing the chosen research method.

Courseware included discussions and sources for problematic concepts in research—such as data saturation, triangulation, and deductive disclosure—to save students time from searching library sources on these topics. Students required extensive time to research their specific topics; the handouts, papers, and course content of the research methods course attempted to shift time to student topics and away from exploring the range of research methods and their variations used by researchers today.

An important element of the second course was holding students accountable for providing quality feedback to their peers during the mock defense presentations. Assessing students on their feedback to peers prompted students to think more critically about the work of others while simultaneously considering the potential shortfalls in their own work. Rather than providing simple affirmations and encouragement, students provided detailed feedback that indicated they had delved deeper into their peers' topics and methodologies than instructors expected. Seminar instructors reported that students were more critical—positively—in their feedback and frequently left the instructors with little to add in their own feedback. It was interesting to hear student reflections on their own developing research projects as they provided their feedback to peers.

While most institutions of higher learning will conduct thesis defenses within a discipline or a department of related disciplines, the CGSC MMAS topics cross many disciplines without the benefit of well-prepared faculty in the researched topics they supervise. Having senior faculty within the CGSC develop a cross-discipline rubric for products (especially the thesis) provided uniformity in expectations while allowing flexibility across disciplines. It also helped develop junior faculty members to take on more significant roles, including thesis committee chair, by facilitating discussions about quality and content within student submissions.

The risk of regulatory noncompliance in human subjects research is always a concern for colleges and universities to the extent that significant noncompliance can result in the termination of student degree programs, risk of institutional liability, and degradation of the community's trust in the institution's research activities. The addition of a CITI training program for all students and select committee members—including history students who typically do not engage in research involving human subjects—increased CGSC student and faculty awareness of what research activities require institutional review and approval. This reduced the CGSC's risk of noncompliance while ultimately preparing current and future faculty (drawn from graduating students) to safeguard human subjects and the institution in future research.

Recommendations

The CGSC thesis program is arguably unique in its design and expectations. CGSC students are limited to only nine months to complete a graduate-level thesis. Yet, analysis of the changes in CGSC's thesis program yielded potentially transferable lessons for other thesis instruction programs.

Sequencing instruction to follow the elements of the research proposal provided just-in-time instruction to complete the proposal. This approach did not overwhelm students, even with the challenges and enormity of the project. Following a logical progression from topic through problem statement and research question development, an organization of the literature review around the research question variables, and then the methodology appropriate to answer the research questions improved alignment within research designs. Routine faculty feedback to discussion board contributions that included postings of problem statements, research questions, variable definitions, and other elements of the research proposal were formative assessments to ensure students understood the course concepts in their application. By the end of the research methods course, students had a viable research proposal.

Augmenting large-group instruction with smaller student working groups facilitated by a faculty member provided a necessary and valued opportunity for students to share their learning. While discussion board posts were valuable (especially for a completely the online course), small group seminars facilitated students sharing and learning outside of their thesis committees. Detailed exposure to other students' designs and challenges reinforced student learning and progress in their own research projects. Assessing the quality of student feedback in the second semester seminars encouraged students to probe and question their peers' work—resulting in a more critical analysis of their own research projects and progress.

Finally, detailed rubrics facilitated student learning as well as calibrated faculty assessments across different academic disciplines. Students probed the meaning behind rubric word pictures resulting in fruitful discussions on expectations across the thesis program and with specific faculty members. Faculty participating as committee members for students researching outside the faculty member's area of expertise had a guide to determine standards and encourage student progress toward those standards. Cross-walking specific elements of the rubric requirements to learning objectives in the course aided the end of program evaluation to determine where instruction, assessments, or course design required adjustment to improve student performance.

Conclusion

COVID forced the CGSC to reassess instruction for its MMAS thesis degree program. As with many other degree-granting institutions, the creation of an online program from what had been exclusively a resident program was conducted in a few months to accommodate the incoming class (Guidi et al., 2023). However, resident and nonresident students completed the revised curriculum due to the consequences of COVID-19's disruption of in-person meetings.

The revised curriculum was successful in graduating a like number of thesis students compared to previous years despite the disruptions of COVID-19 and the necessity to conduct the research methods course entirely online. Student surveys of withdrawn students indicated time management caused them to withdraw from the thesis program whereas the research methods curriculum supported their thesis development. A program evaluation prompted minor revisions in subsequent academic years for resident and hybrid instruction. Those revisions realigned instruction to provide a broad overview of research activities following the outline of the research proposal. Additional detailed instruction and resources helped students better focus their time and energy to complete the thesis within nine months. Learning activities and assessments provided just-in-time instruction and feedback to support student progress through the research design process. The CGSC thesis timeline and program may be different from those of other institutions of higher learning. Yet, some elements of the CGSC redesign could benefit students and institutions of higher learning with more traditional thesis programs without sacrificing quality or relieving research students from a large amount of individual effort to complete a thesis.

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Peer Reviewed

Air Assault!

Applying Learning Science to Army Skill and Knowledge Acquisition

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To ensure force readiness, soldiers in the U.S. Army must acquire critical knowledge and skills at an incredible rate. They are expected to retain and recall this knowledge throughout their careers not only in garrison environments but also in austere, high-stakes, and stressful conditions. As time and resources available for training and education are constrained, it is imperative to optimize these activities using all the resources available to the Army. Although Army schools are highly successful at preparing soldiers for their duties, there are techniques that could improve education and training that have been underexplored in military contexts. Over the past several decades, researchers in the cognitive sciences have identified techniques that reliably enhance long-term learning outcomes, even with little to no investment of time or resources (for relevant reviews, see Cepeda et al., 2006; Firth et al., 2021; Hughes & Thomas, 2021). However, these techniques have overwhelmingly been explored in laboratory settings, civilian educational environments (i.e., kindergarten to college), and sports. The purpose of this study was to explore how learning techniques that require minimal investment of time and resources could be integrated into an Army education and training environment. Specifically, we partnered with the Sabalauski Air Assault School at Fort Campbell, Kentucky, to explore these research questions.

Learning Sciences

Among the most potent learning techniques are practice testing, spacing out learning sessions, and interleaving learning materials. Research overwhelmingly demonstrates that practice testing leads to superior learning compared to an equivalent amount of time reviewing material (for a review, see Adesope et al., 2017). The superiority of practice testing has not only been documented when compared to less effortful study methods like rereading and highlighting but also to deeper, conceptual, and/or elaborative methods of studying (e.g., idea mapping, sentence generation, and creating mnemonic devices; see Karpicke & Blunt, 2011; Karpicke & Smith, 2012). Spacing is another potent technique. The *spacing effect* refers to the finding that it is better to spread out the studying of a topic into multiple instances across time compared to an equal amount of time studying that topic in a single session (e.g., a one-hour learning session on four separate days compared to a single four-hour learning session) (Ebbinghaus, 1885; for reviews, see Cepeda et al., 2006; Delaney et al., 2010). Relatedly, interleaving is a method of reviewing material that is similar to the spacing effect but carries an additional advantage. The *interleaving effect* is the finding that studying various topics in an alternating fashion (ABABABAB) is often better than studying one topic entirely before moving onto another (i.e., *blocking*: AAAABBBB; e.g., Goode & Magill, 1986; Hall et al., 1994; Kornell & Bjork, 2008; for a review, see Firth et al., 2021). Interleaving necessarily involves some degree of spaced learning, since the study of one topic is divided into temporally distinct instances. A unique benefit of interleaving is that it juxtaposes

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different topics, allowing learners to compare and contrast the shared and distinct features of each topic. This juxtaposition, termed *discriminative contrast*, is useful when categories of knowledge share many features in common, making it difficult for learners to notice the subtle differences that separate them (Goldstone, 1996; Kornell & Bjork, 2008; for a review, see Hughes & Thomas, 2021).

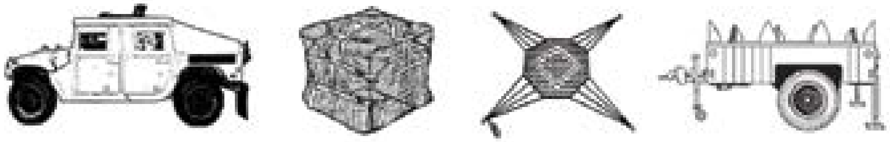
Although these learning techniques entail their own unique advantages, their efficacy is underpinned by similar mechanisms. There are two mechanistic frameworks that parsimoniously explain these benefits. One is the principle of transfer-appropriate processing (Blaxton, 1989; Morris et al., 1977), which states that performance is optimized when the cognitive processes involved in training match those that are called upon during the later testing of those skills. This framework explains why practice testing is effective, as it requires people to recall information from long-term memory, which is precisely what is normally asked of them during their graded exams. Similarly, spacing is effective because when learners are assessed, there has usually been an appreciable amount of time since the last study episode. Spaced learning approximates the experience they will later have when their knowledge or skill level is formally assessed. Another is the principle of desirable difficulty (Bjork, 1994; Bjork & Bjork, 2020), which states that learning is optimized when people are practicing at a moderate level of difficulty. The most used learning techniques are shallow and low effort (e.g., rereading), keeping the level of challenge too low to spur sufficient growth and progress.

To determine where and how these techniques could be implemented at the Sabalauski Air Assault School at Fort Campbell, Kentucky, we conducted focus groups and interviews with the instructor cadre. Overwhelmingly, the cadre expressed that a single component of the air assault course resulted in more failures than any other: identifying errors in equipment rigged to aircraft that would endanger in-flight operations (*sling load inspection*). In this context, the sling is the name for the equipment that attaches cargo (*a load*) to a rotary-wing aircraft. Incorrectly rigging the load to the aircraft can endanger in-flight operations by creating aerodynamic instability. Correct rigging is therefore vital to successful air assault operations. In the present study, we worked with the cadre to modify the training of sling load inspection and compared course outcomes with the previous methods of training.

Sling Load Inspection

In the air assault course, soldiers learn to inspect four loads (see Figure 1): the A-22 Cargo Bag, M1151 HMMWV (i.e., a humvee truck), M1102 Trailer, and 5K Cargo Net. The skill essentially consists of two simultaneous tasks: (a) performing a recommended inspection sequence, a systematic method of reviewing the equip-

Figure 1
Sling Load Types



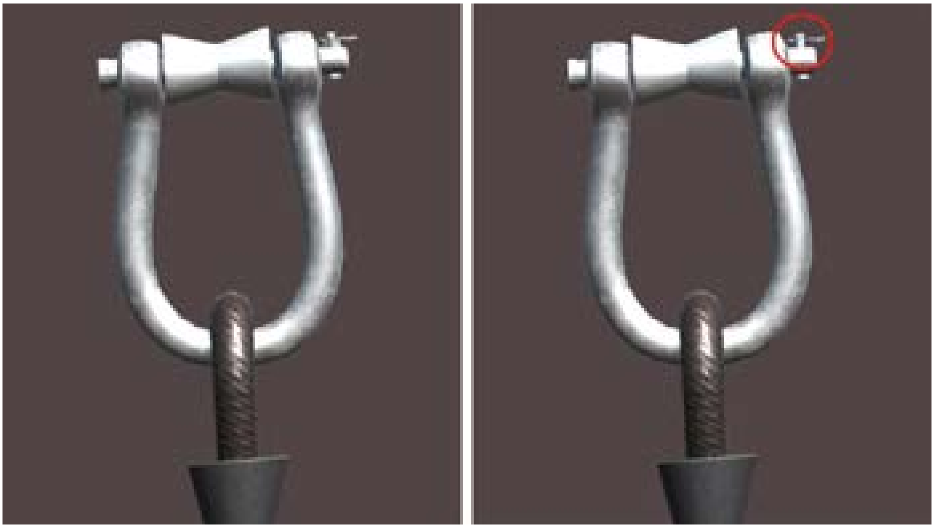
The four types of loads. From left to right: M1151 HMMWV (humvee), A22 Cargo Bag, 5K Cargo Net, and M1102 High Mobility Trailer.

ment in a particular order/manner ensuring full coverage of the rigging and load; and (b) a categorization task in which pieces of the equipment are judged as operable or deficient (see Figure 2). The identification of deficiencies is the true focus of the task, as these are defined as errors in the rigging that would threaten the viability of safe in-flight operations.

To pass the air assault course, soldiers must successfully conduct sling load inspection on four different types of loads (see Figure 1). For each load, soldiers must identify three out of four deficiencies in under two minutes. Although a specific inspection sequence is taught and strongly recommended by instructors, it is not required during testing and soldiers are not penalized for deviating from that sequence. After the first round of testing is complete, soldiers who failed any of the loads receive additional instruction and then are given a second opportunity to conduct the sling load inspection on each type of load they failed. On the second test, the sling loads may have an entirely new set of deficiencies. A soldier who fails any load twice also fails the entire course.

Soldiers are trained on sling load inspection through a mixture of classroom presentations, in-person lectures with the equipment, and hands-on practice (*practical exercises*). Learning science techniques could be integrated into any of these learning activities and/or at-home study materials. For the purposes of our project, we limited our efforts to modifications of the practical exercises that would require virtually no increase in time or resources to implement. We made this decision for three reasons. First, the majority of training time is spent on the practical exercises, meaning that an intervention in this part of the course would likely exert the largest effects on the learning outcomes. Second, modifications to the practical exercises would circumvent adherence problems that would likely occur with voluntary after-hours exercises or with at-home study materials. Third, the practical exercises are the part of the training that is most similar to the actual hands-on sling load inspection test. This means that any improvements in these exercises would be most likely to transfer to the hands-on tests.

Figure 2
Deficiency Example



Note. Left: 10K Apex with no deficiency. Right: 10K Apex with a missing castellated nut in the top right corner of the equipment.

Motivated by the principle of transfer-appropriate processing, we decided to explore how making the practical exercises more like actual testing conditions would affect course outcomes. Recall that testing conditions require soldiers to inspect loads and identify three out of four rigged deficiencies in under two minutes per load. The practical exercises deviate from these conditions in two critical ways. First, half of these exercises are performed on *clean* loads, which have no deficiencies rigged on the equipment, but soldiers are only presented with loads that *do* have deficiencies during testing conditions (*dirty loads*). Second, the practical exercises are not timed, meaning that soldiers never get accustomed to the feeling of time pressure and/or establish an appropriate pace and rhythm for conducting their inspections. The cadre emphasized that soldiers frequently struggled with the time pressure of their tests, causing many soldiers to go too quickly or too slowly. Therefore, we had the cadre make all the practical exercises done with (a) only dirty loads (four deficiencies rigged on the equipment) and (b) time pressure. The cadre decided to set the timers for three minutes rather than the two-minute standard used during actual testing conditions. Although this timing component did not precisely reflect testing conditions, it perhaps struck a balance between making the practical exercises more test-like and making the task too difficult for novices (i.e., two minutes may have been undesirably difficult).

Notably, conducting the practical exercises with all dirty loads challenged an intuitive notion held by many members of the cadre, which is that time spent with clean loads is uniquely valuable for honing the skill of sling load inspection. The basic idea is that by spending time with clean loads, a soldier learns "what right looks like," and consequently, deviations from "right" would leap out at the soldier, who would then call out a deficiency. Replacing this time with more exposure to dirty loads would hypothetically put the cart before the horse, undermining the acquisition of what "right" looks like.

There is ample scientific evidence to call this notion into question. This comes from a literature on visual category learning, which investigates similar skills to sling load inspection but with different materials. Sling load inspection is fundamentally a series of discrete visual categorization tasks in which soldiers deem subcomponents of the rigging as belonging to one of two categories: functional or deficient. Although the inspection sequence involves interacting with the equipment physically, the categorization component of the task is primarily visual in nature. The deficiencies are identified based on appearances rather than tactile cues (e.g., the absence of a castellated nut, a twist in a strap, or a misrouted chain can all be identified by sight alone; see Figure 2). Visual categorization experiments, such as those that involve determining whether chest X-rays exhibit healthy lungs or signs of disease, involve the same underlying cognitive mechanisms.

In the terminology of the research on visual category learning, some members of the cadre saw value in "blocking" the study of categories (i.e., study the category of "clean" before "dirty"). Early researchers examining visual categorization felt similarly, arguing that it makes sense to master one category before moving onto another (e.g., for categories clean [C] and dirty [D], the sequence could look like: CCCCDDDD; see Gagné, 1950; Kurtz & Hovland, 1956). However, this method is usually not as effective as alternating between examples of each category (i.e., *interleaving*; CDCDCDCD), especially when the features that discriminate the categories are subtle deficiencies (for a review, see Hughes & Thomas, 2021), which is typical of sling load inspection (e.g., the orientation of a small castellated nut can distinguish between clean and deficient; see Figure 2). Interleaving is beneficial for learning because it highlights and draws attention to the critical differences between categories (e.g., clean vs. dirty), making the learning process more efficient by promoting *discriminative contrast* (Goldstone, 1996; Kang & Pashler, 2012; Kornell & Bjork, 2008). In the context of sling load inspection, interleaving would mean examining a *clean* version of a piece of equipment (e.g., a correctly rigged 188-inch strap) and then studying a *dirty* version of that equipment (a version *with* a deficiency; e.g., a twisted 188-inch strap). This type of juxtaposition would only occur during dirty load sessions because they entail a mixture of clean and dirty equipment. An additional benefit of this kind of study method is that it keeps learners engaged. Blocked learning sequences tend to be too predictable and result in boredom (Guzman-Munoz, 2017).

Method

Participants

We obtained data from a total of 2,826 soldiers who participated in the sling load portion of the air assault course. The treatment group consisted of six classes ($\mathcal{N}$ = 656). The control group was composed of the preceding fourteen classes ($\mathcal{N}$ = 2,170). Each class was taught by one of three instructor teams.

Procedure

The Combined Academic Institutional Review Board of Army University provided a human subjects research determination of exempt research project with concurrence from the U.S. Army Combat Capabilities Development Command Soldier Center Human Research Protections Office. The exempt categorization was due to the research occurring in normal established classroom settings, involving normal educational practices, and being unlikely to negatively impact students' ability to learn required educational content. For the treatment classes, we had the cadre brief soldiers on our efforts to evaluate the efficacy of course modifications and inform soldiers that they could opt out of their data via a web link. No soldiers opted to withhold their data from the project.

In the treatment classes, we had the cadre modify the practical exercises in six classes by (1) replacing all clean loads (no deficiencies rigged) with dirty loads (four deficiencies rigged) and (2) introduce time pressure by limiting soldiers to three minutes per sling load practical exercise. For the control classes, we asked the cadre to provide historical data from the preceding classes, which we used as baseline performance levels. For all classes, we asked the cadre to record the performance of each soldier for each load on the initial test and the retest. We also requested the cadre provide us with individual soldier characteristics that they identified as significant predictors of performance, which included soldier rank and temporary duty status (whether a soldier was permanently stationed at Fort Campbell or was on orders from another location).

Results

We used fixed and mixed logistic regression modeling to analyze binary outcome data and adopted an alpha rate of .05. The analyses were conducted in R (R Core Team, 2022). We used the *lme4* package (Bates et al., 2014) for logistic regression modeling and the *emmeans* package for analyzing estimated marginal means (Lenth, 2020). The primary dependent variable of interest was whether a soldier passed the hands-on sling load test. We were unable to analyze the data in a more granular way, as the

Table 1

Instructor Teams: Percentage of Soldiers Taught in the Sample and Overall Pass Rate

		Instructor Team		
		A	B	C
Composition	Control	40%	24%	36%
	Treatment	31%	28%	41%
	Total Sample	38%	25%	37%
Pass Rate	Control	68%	91%	79%
	Treatment	82%	88%	85%
	Total Sample	70%	90%	81%

schoolhouse only provided us with performance data on each test (first or retest) and each load for less than half of the collected sample (for 1,142 out of the 2,826 soldiers). An analysis on this subset of data would be problematic because we would be unable to control for several contaminating factors, the importance of which will become clear in the subsequent analysis. Note that of the six treatment classes, only four incorporated the element of time pressure. Nevertheless, we analyzed all six treatment classes as a single unit, as all of them used dirty loads during the practical exercises.

Hands-on Sling Load Test

For the hands-on sling load test, soldiers in the treatment group ($\mathcal{M}$ = 84.99%) outperformed those in the control group ($\mathcal{M}$ = 77.30%) by 7.69 percentage points, $\beta = .51$, $p < .0001$. However, there were differences across the groups that could have accounted for this increase in pass rate rather than the modified practical exercises. To evaluate this possibility, we examined the contribution of several variables the schoolhouse cadre identified as potential confounds, including average class size, instructor teams, and two variables pertaining to class composition (TDY status and soldier rank). Ultimately, we planned to fit a model that accounted for any of the factors that may have unfairly influenced the between-groups comparison.

Class Size. The average class of the treatment group ($\mathcal{M}$ = 111) was smaller than that of the control group ($\mathcal{M}$ = 171), suggesting the possibility that the smaller class size underlay the enhanced pass rate. However, the pass rate of the smallest 10 classes ($\mathcal{M}$ = 79%) was not reliably different than the largest 10 classes ($\mathcal{M}$ = 79%), $t(18) = 0.08$, $p = .94$, $d = 0.03$. We therefore did not include this variable in our final model.

Instructor Teams. The number of soldiers taught by each instructor group was not equal across groups, $X^2(2) = 16.69$, $p < .001$ (see Table 1). For example, 40% of

Table 2
Sample Composition and Pass Rate Across Levels of TDY Status

		Local	TDY
Composition	Control	82%	18%
	Treatment	72%	28%
	Total Sample	80%	20%
Pass Rate	Control	75%	87%
	Treatment	83%	91%
	Total Sample	77%	88%

soldiers in the control group were taught by Team A, but only 31% of soldiers in the treatment group were taught by Team A. This was problematic because the overall pass rate of Team A (70%) was lower than Teams B (90%) and C (81%), suggesting a confound in the difference in pass rates among the groups.

TDY Status. Next, we looked at whether each soldier's home station was Fort Campbell, meaning that the air assault school was local to them, or if they were traveling to attend this course from another installation (i.e., they are on temporary duty or TDY). As shown in Table 2, soldiers who were TDY ($\mathcal{M}$ = 88%) passed at a higher rate than those who were local ($\mathcal{M}$ = 77%), $\beta = .82$, $p < .0001$. On average, the proportion of TDY soldiers was higher in the treatment group ($\mathcal{M}$ = 28%) compared to the control group ($\mathcal{M}$ = 18%), $\beta = .58$, $p < .0001$, resulting in an artificial advantage of the former over the latter.

Soldier Rank. We next turned our attention to soldier rank. For the sake of a simpler analysis, we created three bins for soldier rank: junior enlisted, senior enlisted, and officer. As shown in Table 3, higher rank soldiers ($\mathcal{M}$ = 90%) passed at a higher rate than lower ranked soldiers ($\mathcal{M}$ = 76%), $\beta = 1.10$, $p < .001$. As shown in Table 3, the rank composition of the treatment and control groups were not identical, $X^2(2) = 37.13$, $p < .001$. For example, junior-enlisted soldiers were a greater proportion of the control ($\mathcal{M}$ = 56%) compared to the treatment group ($\mathcal{M}$ = 43%). Again, this was a confound that benefited the pass rate of the treatment group.

Final Model

We used mixed-effects logistic regression to create a model that predicted the effect of treatment group on pass rates while accounting for instructor teams (random effect), TDY status (fixed effect), and rank (fixed effect). Treatment group was coded as 0 (control) or 1 (treatment); TDY status as 0 (local) or 1 (TDY); and rank as 0 (en-

Table 3
Sample Composition and Pass Rate Across Levels of Soldier Rank

		Rank Category		
		Junior Enlisted	Senior Enlisted	Officer
Composition	Control	55%	25%	20%
	Treatment	42%	34%	24%
	Total Sample	52%	27%	21%
Pass Rate	Control	70%	84%	90%
	Treatment	79%	89%	92%
	Total Sample	71%	85%	90%

listed) or 1 (officer).[1] We evaluated the significance of the fixed and random effects by conducting chi-square likelihood ratio tests on the change in model fit (deviance) on a model-to-model basis (for the model outputs, see Table 4). The degrees of freedom of these chi-square tests is the difference in the number of model parameters between the two tested models. We added effects one at a time, and if the model fit improved at a statistically significant level, then we deemed that effect significant. Notably, the model terms in this analysis are in log-odds units rather than the probability scale (i.e., probability of passing the hands-on test). Where appropriate, we convert these log-odds outcomes to probability scale to aid interpretability of the results.

We started with a null model, which included only an intercept and no fixed or random effects. We then added a random effect of instructor team, which significantly improved model fit, $X^2(1) = 99.08$, $p < .001$, confirming significant variation in performance across teams. Next, we added TDY status as a fixed-effects predictor, which was also significant, $X^2(1) = 40.43$, $p < .001$. Soldiers who were on TDY ($\mathcal{M}$ = 92%) passed their tests at a higher rate than those who were not ($\mathcal{M}$ = 85%). There was an effect of soldier rank, $X^2(1) = 59.80$, $p < .001$, and a TDY-by-rank interaction, $X^2(1) = 3.92$, $p = .048$. For enlisted soldiers, those who were on TDY ($\mathcal{M}$ = 89%) significantly outperformed those who were not ($\mathcal{M}$ = 77%), but the same was not true for officers ($\mathcal{M}$ = 92% and 93%, respectively). There was an effect of group, $X^2(1) = 8.58$, $p = .003$, but none of the two-way or three-way interactions with group were significant (ps > .36). To quantify the effect of group, we calculated estimated marginal means

[1] We treated soldier rank as a binary variable (enlisted = 0, officer = 1) to avoid an excessive number of model terms and convergence issues.

Table 4
Output of Mixed-Effects Modeling Analysis of Hands-on Go Rate

		Model Number								
		1	2	3	4	5	6	7	8	9
Fixed Effects	Intercept	1.33	1.51	1.37	1.23	1.21	1.14	1.14	1.14	1.13
	TDY	-	-	0.84	0.75	0.88	0.84	0.85	0.84	0.87
	Rank	-	-	-	1.07	1.22	1.22	1.21	1.27	1.31
	TDY*Rank	-	-	-	-	-0.73	-0.70	-0.70	-0.69	-0.86
	Group	-	-	-	-	-	0.36	0.37	0.41	0.43
	TDY*Group	-	-	-	-	-	-	-0.07	-0.03	-.017
	Rank*Group	-	-	-	-	-	-	-	-0.33	-0.51
	TDY*Rank*Group	-	-	-	-	-	-	-	-	0.71
Random Effects	Team (Variance)	-	0.32	0.33	0.35	0.35	0.35	0.34	0.35	0.35
Model Statistics	Deviance	2894.3	2795.2	2754.8	2695.0	2691.1	2682.5	2682.4	2681.6	2680.9
	$p(\Delta\text{Deviance})$	-	< .001	< .001	< .001	.048	.003	.839	.369	.398

Note. Fixed and random effect values are model coefficients (β) in log-odds units. Statistics on model fit (residual deviance) reflect the change in deviance from one model to the next, with lower values indicating better fit.

that were weighted according to characteristics of the entire sample (e.g., both group means were weighted assuming 14% of soldiers were both enlisted and on TDY, which was the overall sample average across groups). As shown in Table 5, the advantage of the treatment group ($\mathcal{M}$ = 87.41%) over the control group ($\mathcal{M}$ = 81.75%) was 5.66 percentage points, which was 2.03 points smaller than the raw data means that did not account for differences between groups in the variables of interest.

Discussion

The results of this experiment suggest that the practical exercises should be made more like actual testing conditions by (1) using only loads rigged with deficiencies and (2) incorporating time pressure. After accounting for differences in sample composition between the control and treatment groups (e.g., rank composition), the two changes to the practical exercises resulted in a 5.66% increase in sling load pass rates. This increase was achieved at essentially no additional investment of time or resources. This seemingly modest increase in pass rate scales up to a significant im-

Table 5
Raw and Model-Adjusted Pass Rates

	Pass Rate	
	Raw	Model Adjusted
Composition Group	77.30%	81.75%
Treatment Group	84.99%	87.41%
Δ Pass Rate	+7.69%	+5.66%

Note. The raw pass rates do not account for any of the intergroup confounding variables (i.e., differences in instructor team representation, average soldier student rank, and average soldier student TDY status). The model-adjusted pass rates are the estimated marginal means of the final mixed-effects model (on the probability scale), which takes all three variables into account.

pact across an entire year of air assault courses. We observed an average class size of 153 soldiers, and we would expect approximately 125 of those soldiers (81.75%) to pass the sling load inspection test with the traditional practical exercises. With the modified practical exercises, we would expect approximately 134 soldiers (87.41%) to pass that portion of the class, an increase of nine soldiers. The Sabalauski Air Assault School conducts about 40 air assault classes per year, meaning that the modified practical exercises would lead to roughly 360 more soldiers passing their sling load inspection annually. The modified practical exercises would therefore result in an increase of about 2.88 classes worth of sling-load test graduates (i.e., 360/125). Increasing pass rates at the air assault course represents a force multiplier, both directly through increasing the number of air assault certified soldiers and indirectly by opening up space for more soldiers to take the course. Critically, the increases in pass rates that we observed in the present study were accomplished without modifying the long-established Army standards.

Limitations

One limitation of the present experiment was that although all six of the treatment classes only used dirty loads during the practical exercises, only four of those classes incorporated the element time pressure. It is not possible to determine the separate and joint contributions of each change. Nevertheless, we do suspect that replacing the clean loads with dirty loads made the larger contribution to the increased pass rate. After implementing the change in load type, pass rates increased and remained stable with the addition of time pressure. Of course, future work would be needed to resolve these questions. Another limitation is that we could not examine performance on the individual loads with an adequate level of precision due to gaps in the data set. It is conceivable, for example, that the changes to the practical exercises affected some loads more than others (e.g., preferentially improved the easiest or hardest).

Future Directions

The learning sciences can be applied to other areas of the air assault course. Practice testing, spacing, and interleaving can be incorporated into classroom activities and/or review materials for use outside of the classroom. We investigated the latter option in another research study, which involved deploying learning content through a web-based and mobile learning platform (Craig et al., 2023). Within the classroom, the lectures could be periodically punctuated by small practice tests or brief review of previously introduced content (i.e., spacing). Of course, these types of interventions could be applied to any other course that requires fact-based learning and/or physical skills. For these categories of learning interventions, there are many potential ways to implement them, which can have measurable impacts on outcomes (e.g., the type and/or timing of feedback during practice testing; e.g., Maddox et al., 2003; Pashler et al., 2007). Moreover, these techniques can be combined with other types of learning techniques, like elaborative encoding (e.g., creating links with old knowledge or generating memory mnemonics; Levin, 1988; McDaniel, 2023) or fading (sequencing material by level of difficulty; Pashler & Mozer, 2013).

Low-lift learning science interventions can also be applied to other Army schoolhouse settings. Of course, the results of our present work are most directly relevant to similar tasks trained elsewhere, like equipment inspection at the Advanced Airborne School (i.e., jumpmaster personnel inspection). That said, given that these techniques have been successful across a wide range of disparate tasks in civilian populations (e.g., radiology, art history, basketball), we have little reason to doubt the same would be true for cases of military application. For example, air defense artillery airframe identification involves categorizing different types of aircraft based on the noises they produce. As with the visual domain, learning auditory discrimination benefits from interleaved learning sequences due to similar cognitive mechanisms (see Chen et al., 2015; Wong et al., 2020; Wong et al., 2021). The results of the present experiment would therefore likely extend to that context and possibly much less similar tasks.

One potential challenge of integrating effective learning science techniques into Army education settings is a common metacognitive illusion. Namely, the use of effective learning techniques often causes people to feel less confident in their learning outcomes than less effective alternatives (e.g., Roediger & Karpicke, 2006). This is likely because the more effective techniques tend to be harder, forcing learners to become aware of gaps in their knowledge that less demanding techniques, like rereading notes, would not. Consequently, learners sometimes prefer the less-effective alternative because they falsely construe it as superior (Karpicke, 2009). For this reason, Army educators should consider educating soldiers about this metacognitive conundrum and inform them that difficulties experienced during learning process are often signs of progress, not evidence of failure.

Working with the schoolhouses, as opposed to the course proponent, has advantages and disadvantages. The main advantage is that implementing these relatively minor changes to Army courses only requires the commander's discretion as they are not changes in the program of instruction. In addition, working with the schoolhouse leadership and cadre directly affords an opportunity to increase buy-in, which in turn can increase the probability of a successful outcome. However, there are two major disadvantages that should be considered: (1) future schoolhouse leadership can just as easily undo any course modifications, and (2) any potential changes to a course must not conflict with the program of instruction (i.e., the curriculum that is designed by the proponent). For these reasons, the proponent would be an important stakeholder for similar future research efforts.

Incorporating the findings of the present study into the training and education of future instructors and curriculum developers will aid the dissemination throughout the enterprise, regardless of location or proponent. The Common Faculty Development Instructor Course and the Common Faculty Development Developer Course, both taught by the Army University, could be additional areas to translate research findings to improve the quality of output in instruction, lesson plans, and curriculum design that directly impacts student outcomes across the Army Learning Enterprise.

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Upcoming Conferences of Note

June 24–28, 2024 (Hybrid): Army University Learning Symposium

Fort Leavenworth, KS

https://armyuniversity.edu/Organizations/LearningSymposium/Home

The Army University Learning Symposium brings training and education professionals from the military, government, industry, and academia together to exchange ideas and promote cutting-edge learning science. Themes of this year's conference are learning assisted by artificial intelligence, learning organizations, learning science and technologies, learning data, and learning strategies.

July 15–17, 2024: Anthology Together (formerly Blackboard World Conference)

Orlando, FL

https://www2.anthology.com/together

AT24 is the destination for industry thought leaders and education professionals from all backgrounds and experiences, featuring keynotes by industry insiders, peer-driven discussions, best practices, and a variety of networking opportunities.

August 8–10, 2024 (Hybrid): American Psychological Association Convention

Seattle, WA

https://convention.apa.org/attend/future-conventions

APA2024 is the world's largest gathering of psychologists, psychology students, and other mental and behavioral health professionals. This is an opportunity to discuss education and behavioral sciences specifically tailored to the military population with a wide variety of experts.

October 8, 2024 (Virtual)/October 29–November 1, 2024 (In Person): American Association for Adult and Continuing Education (AAACE) Conference

Reno, NV

https://www.aaace.org/page/2024-conference

This is the annual conference of one of the nation's largest organizations for adult and continuing education. The American Association for Adult and Continuing Education (AAACE) is the publisher of three leading adult education journals: *Adult Education Quarterly*, *Adult Learning*, and the *Journal of Transformative Education*.

October 14–16, 2024: Association for Continuing Higher Education (ACHE)

Palm Springs, CA

https://www.acheinc.org/events/ache-2024-annual-conference

The Association for Continuing Higher Education (ACHE) is a dynamic network of diverse professionals who are dedicated to promoting excellence in continuing higher education and to sharing their expertise and experience with one another.

October 14–16, 2024: Association of the United States Army (AUSA) Annual Meeting & Exposition

Washington, D.C.

https://meetings.ausa.org/annual/2024/

The Association of the United States Army (AUSA) Annual Meeting and Exposition is the largest landpower exposition and professional development forum in North America. The annual meeting is designed to deliver the Army's message by highlighting the capabilities of Army organizations and presenting a wide range of industry products and services. AUSA accomplishes this task throughout the entire event by providing informative and relevant presentations on the state of the Army, panel discussions and seminars on pertinent military and national security subjects, and a variety of valuable networking events available to all who attend.

October 30–November 1, 2024 (Hybrid): Council for Adult and Experiential Learning (CAEL) Conference

New Orleans, LA

https://www.cael.org/2024-cael-conference

The annual conference brings together over 500 participants to learn, network, and work together to make lifelong learning accessible to adults around the world. Attendees include college faculty and administrators, human resources professionals, workforce developers, and representatives from labor and government.

November 10–14, 2024 (Hybrid): Professional and Organizational Development (POD) Network Conference

Chicago, IL

https://podnetwork.org/49th-annual-conference/

The POD Network Conference focuses on the community of scholars and practitioners that advance the scholarship of teaching and learning through faculty development.

November 17–20, 2024: Institute for Credentialing Excellence (ICE) Exchange

Miami Beach, FL

https://www.ice-exchange.org/

The ICE Exchange is an annual gathering for the credentialing community to exchange ideas on industry trends and best practices, connect, and participate in high-quality education.

December 2–6, 2024: Interservice/Industry Training, Simulation & Education Conference (I/ITSEC)

Orlando, FL

https://www.iitsec.org/

The world's largest modeling, simulation, training, and education conference allowing participation in education paper presentations and networking among government, industry, and academia peers and subject-matter experts.

The Army University Research Program
(January–December 2023)

Background

The Army University Research Program (AURP) is a learning sciences research program with the aim of improving education across the enterprise with innovative projects that address specific needs. The AURP was created by the vice provost of academic affairs (VPAA), Army University (ArmyU) in 2019 to support evidence-based innovation in the learning enterprise. It is an inclusive program: one needn't be a researcher by trade to contribute. Practitioners can be faculty/instructors, curriculum or faculty development staff, students, or research staff.

The administration of the AURP rests in the Institutional Research and Assessment Division (IRAD), VPAA, ArmyU. The AURP uses the Army Learning Coordination Council structure to drive oversight of research projects via recommendations from the Learning Continuum Committee (LCC). AURP activities are managed by one of the five LCC subcommittees, the Learning Sciences Subcommittee (LScS). The LScS serves as the principal working group and advisory body to the LCC concerning learning science and research. The IRAD chief is the permanent cochair of the LScS. Another scientist within the community serves as cochair. The charter for the LScS is available from the LScS SharePoint page at https://armyeitaas.sharepoint-mil.us/sites/tr-cac-au-vpaa/SitePages/Learning-Sciences-Committee.aspx.

The strengths of AURP projects rest with the fact that, as mentioned previously, topics can be proposed by anyone and the research is done in a collaborative environment with investigators from organizations as varied as IRAD, the Center for Army Leadership, the Army Research Institute, the U.S. Army Institute for Religious Leadership, the Sabalauski Air Assault School, the U.S. Army Combat Capabilities Development Command-Soldier Center, the Sustainment Center of Excellence, and U.S. Northern Command gender advisors. This makes certain that products or policies developed through this process have had input from potential user groups and subject-matter experts.

AURP Projects and Status

Since its introduction at the November 2019 meeting of the LScS, the AURP has resulted in nine supported research projects. The Table provides an overview of projects.

Table

Supported Research Projects Since 2019

Title and Year Begun	Project Description
Survey of the Army Learning Enterprise (SALE) (2019)	SALE provides an enterprise-level overview of professional military education (PME) from the student perspective after they return to the operational force. The main aims are (1) to facilitate the collection of best practices, lessons learned, and techniques, tactics, and procedures from those who are excelling; and (2) to facilitate the identification and remediation of barriers to success. SALE is now a command-directed project.
Tacit Knowledge Transfer (2019)	Tacit knowledge refers to the knowledge, skills, and abilities an individual gains through experience that is often difficult to put into words or otherwise communicate. Understanding tacit knowledge and how it is transferred within the total force is critical to improve the military's agility, adaptability, and speed of responding to any challenges presented by adversaries.
Defining and Quantifying Rigor in Army PME (2020)	The term "academic rigor" is often used within Army doctrine and heard within command directives. However, there is not a common understanding of what is meant by "academic rigor" within PME. The aims of this project are to (1) create a common understanding in the context of PME of the term "academic rigor" and (2) develop tools to measure and evaluate the level of rigor in specific courses. This project has transitioned from AURP purview to ArmyU for pilot testing.
Applying Learning Science to Skill and Knowledge Acquisition (ALSSKA) (2020)	Academic research in learning and memory has validated several strategies to optimize the acquisition and retention of knowledge and skills. The aim of this project is to establish (1) learning outcomes associated with strategies for skill and knowledge acquisition; and (2) practices of value, lessons learned, and tactics, techniques, and procedures associated with the implementation of strategies. The final research reports are complete and will be published in 2024.
Improving Self-Regulated Learning (SRL) Through Assessment and Feedback in a Distributed Learning Environment (2021)	For learning to be successful, students must be proficient in self-regulation skills including planning, goal setting, discipline, and focus. The aim of this project is to determine whether providing learner-centric assessments along with adaptive feedback and strategies for optimizing skills in self-regulation improves learning outcomes in a distributed learning environment. The key planned product of this project is an assessment and feedback tool leveraging adaptive learning technology to improve SRL skills.
Identifying Best Practices for Instructor Training for Virtual Learning (2022)	As the Army looks to modernize, Army instructors may increasingly be tasked to teach in a distributed learning environment. This will likely involve instructing online through platforms such as MS Teams or Blackboard. The aims of this project are (1) to identify best practices and challenges for virtual learning (VL) instructors and (2) to develop recommendations for VL instruction that can be used throughout the learning enterprise. The final research reports are complete and will be published in 2024.
Assessing Affective Domain Growth in Soldiers (2022)	The affective domain is "the domain that examines a student's ability to internalize what is learned in the form of feelings and attitude" (TRADOC Regulation 350-70, *Army Learning Policy and Systems*, 2017, p. 127). The aim of this project is to develop an affective domain assessment for use in Army training and education contexts. We propose utilizing existing, scientifically validated scales to help build an assessment of the affective domain to be used in Army training and education contexts.
Diagnostic Classification Models for Army Education, Training, and Development (2023)	The aim of this project is to compare the effects of traditional normative approaches to cognitively diagnostic assessment and diagnostic classification modeling (DCMs)—criterion-referenced approaches to estimating knowledge, skills and behavior mastery, and providing feedback. Moreover, this research intends to explore which information from DCMs can best inform Army feedback, reporting, and development processes along with how advancements in artificial intelligence can help facilitate the adoption, usage, and utility of these approaches.
Predicting Operational Performance in OBME (2023)	The implementation of Outcomes-Based Military Education (OBME) in PME requires defining and achieving operationally relevant outcomes. This project is framed within the Captains Career Course and aims to develop measures of graduate success that are targeted, measurable, and predicted by formative and summative course assessments.

AURP Way Forward

As the AURP grows, additional programmed funding will be required for contracted research support and to transition products to the operational force. Every year, new, varied, and relevant research ideas are proposed to the LScS; it is hoped that collaborations and support through the LScS continue to grow, and the Army Learning Enterprise can produce better educated soldiers through these efforts.

Call for Papers

The *Journal of Military Learning (JML)* is a peer-reviewed, semiannual publication that supports efforts to improve education and training for the U.S. Army and the overall profession of arms.

We continually accept manuscripts for subsequent editions with editorial board evaluations held in April and October. The *JML* invites practitioners, researchers, academics, and military professionals to submit manuscripts that address the issues and challenges of adult education and training such as education technology, adult learning models and theory, distance learning, training development, and other subjects relevant to the field. Submissions related to competency-based learning will be given special consideration.

Submissions should be between 3,500 and 5,000 words and supported by research, evident through the citation of sources. Scholarship must conform to commonly accepted research standards such as described in *The Publication Manual of the American Psychological Association*, 7th edition.

Do you have a "best practice" to share on how to optimize learning outcomes for military learners? Please submit a one- to two-page summary of the practice to share with the military learning enterprise. Book reviews of published relevant works are also encouraged. Reviews should be between 500 to 800 words and provide a concise evaluation of the book.

Manuscripts should be submitted to usarmy.leavenworth.tradoc.mbx.armyu-journal-of-military-learning@army.mil by 1 April and 1 October for the October and April editions respectively. For additional information, send an email to the address above.

Author Submission Guidelines

Manuscripts should contain between 3,500 to 5,000 words in the body text. Submissions should be in Microsoft Word, double-spaced in Times New Roman, 12-point font.

Manuscripts will use editorial style outlined in *The Publication Manual of the American Psychological Association*, 7th edition. References must be manually typed. (The automatically generated references employed by Microsoft Word have proven to be extremely problematic during conversion into final layout format for publication, causing delays and additional rekeying of material.) Manuscripts that arrive with automated references will be returned to the authors for compliance with submission requirements. Bibliographies will not be used and should not be submitted with manuscripts.

Submissions must include a one-paragraph abstract and a biography not to exceed 175 words in length for each author. Such biographies might include significant positions or assignments, notes on civilian and military education together with degrees attained, and brief allusions to other qualifications that establish the bona fides of the author with regard to the subject discussed in the article. Do not submit manuscripts that have been published elsewhere or are under consideration for publication elsewhere.

Authors are encouraged to supply relevant artwork with their work (e.g., maps, charts, tables, and figures that support the major points of the manuscript. Illustrations may be submitted in the following formats: PowerPoint, Adobe Illustrator, SVG, EPS, PDF, PNG, JPEG, or TIFF. The author must specify the origin of any supporting material to be used and must obtain and submit with the article permission in writing authorizing use of copyrighted material. Provide a legend explaining all acronyms and abbreviations used in supplied artwork.

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The editors may suggest changes in the interest of clarity and economy of expression; such changes will be made in consultation with the author. The editors are the final arbiters of usage, grammar, style, and length of article.

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Manuscripts should be submitted to usarmy.leavenworth.tradoc.mbx.armyu-journal-of-military-learning@army.mil by 1 April and 1 October for the October and April editions respectively. For additional information, send an email to the address above.