Peer Reviewed

Tacit Knowledge Cultivation as an Essential Component of Developing Experts

LisaRe Brooks Babin and Alice J. (Sena) Garven
Army University

Abstract

As the U.S. military leans forward in shaping the future of military learning, it is essential to better understand and cultivate not only explicit knowledge acquisition but also the tacit knowledge that is needed to become an expert in any area (Army University, 2017). Understanding tacit knowledge and how it is transferred within the total force will improve the military's agility, adaptability, and speed of responding to any challenges presented by adversaries. To accomplish this, metrics need to be created and assessments must be developed that measure both explicit and tacit knowledge informing talent management, training, and employment of the total force for future military operations.

Introduction

I shall reconsider human knowledge by starting from the fact that we can know more than we can tell.

-Michael Polanyi, *The Tacit Dimension* (1966b, p.4)

Understanding the components of human knowledge has been studied and debated for decades, but scientists in general support the use of two categories of knowledge: (1) explicit knowledge and (2) implicit (tacit) knowledge (Mohajan 2017; Purković, 2018). Additionally, there is renewed interest by the industry and military in the study of human knowledge and knowledge management to achieve a competitive advantage over adversaries (Department of Defense, 2018; Mohajan, 2017; Seidler-de Alwis & Hartmann, 2008).

The authors will first compare and contrast tacit and explicit knowledge to set a strong foundation for the reader. The second section will underline how tacit

knowledge is essential to improving the military's ability to remain competitive and resilient under volatile, uncertain, complex, and ambiguous situations. The third section will discuss assessments that have been created to measure tacit knowledge in a military population. Lastly, the article will conclude with a research-focused way forward to assess tacit knowledge transfer in military education and training to improve future military learning.

Explicit and Tacit Knowledge

Army Techniques Publication (ATP) 6-01.1 defines tacit knowledge as

> What individuals know; a unique, personal store of knowledge gained from life experiences, training, and networks of friends, acquaintances, and professional colleagues. It includes learned nuances, subtleties, and workarounds. Intuition, mental agility, and response to crises are also forms of tacit knowledge. (U.S. Department of the Army [DA], 2015a, p. 1-3)

In contrast, ATP 6-01.1 states that

> Explicit knowledge is codified or formally documented knowledge organized and transferred to others through digital or non-digital means. Explicit knowledge has rules, limits, and precise meanings. Examples include computer files, dictionaries, textbooks, and Army and joint doctrinal publications. (DA, 2015a, p. 1-3)

The father of tacit knowledge, Michael Polanyi, (1966a) described tacit knowledge by using a bicycle analogy. He asserted that being able to ride a bike had nothing to do with reading about riding (explicit knowledge) but more about being able to find one's own balancing point and coordinate multiple muscles to successfully

LisaRe Brooks Babin, PhD, is a research psychologist for the Institutional Research and Assessment Division of the Office of the Provost at Army University. She earned her PhD in learning and comparative experimental psychology at the University of Montana and studies leadership needs for Army training and education in her current position.

Alice J. (Sena) Garven, PhD, is the chief of the Institutional Research and Assessment Division of Army University. Previously, she spent 13 years working with the Army Research Institute. She received her PhD in social psychology from the University of Nebraska-Lincoln and has been a researcher for the Army for over 15 years.

ride the bike without awareness of doing so (tacit knowledge). Other examples of tacit knowledge are: playing sports (Gerrard & Lockett, 2018); making bread (Nonaka, 1991); playing music (Mládková, 2008); conducting medical procedures (Edmonson, Winslow, Bohmer, & Pisano, 2003); and making leadership decisions (DA, 2015b). In fact, many military activities, like conducting key leader engagements and advising and assisting partners, rely heavily on tacit knowledge acquisition (Brown, 2018; Nash & Magistad, 2010).

As stated by Polanyi (1966b) in the epigraph, it is possible that there is knowledge that is difficult to convey with words, but how much of that tacit knowledge can be explicated is yet to be determined in the literature. It is likely that learning is a continuum of acquiring and integrating knowledge that makes measurement of both explicit and tacit knowledge difficult to fully tease apart. As stated by Seidler-de Alwis and Hartmann (2008), "Tacit and explicit knowledge are complementary, which means both types of knowledge are essential to knowledge creation" (p. 134). Luckily though, philosophers, educators, and practitioners have spent decades evaluating how humans learn and the types of knowledge that are gained from different experiences. In addition, much is known about the factors that influence learning and, specifically, tacit knowledge.

From the literature, knowledge can be categorized into "strings and things" (Collins, 2010, p. 85) or depicted as a continuum, as mentioned above. If the salient features of tacit and explicit knowledge can be identified and the features are distinct, researchers can categorize and measure the knowledge separately. Jasimuddin, Klein, and Connell (2005) identified salient features of explicit and tacit knowledge. Specifically, explicit knowledge is categorized by information that is codified, easy to articulate, communicated and stored in media and other concrete physical locations, impersonal, and owned by an organization not an individual person. The opposite of each are the factors that relate to tacit knowledge: noncodified; personal; difficult to articulate, communicate and store; located solely in the individual's brain; acquired through face-to-face exchanges, like storytelling; and owned by the organization and its members.

The problem with categorizing knowledge into two discrete boxes is that you may miss the important overlap that exists if learning is indeed a continuum. There is also a danger in forcing an artificial categorization where you misrepresent the knowledge to make things look neat and orderly. On the other hand, the benefit of categorization is that it is a place to start, especially when it comes to learning how to improve the knowledge acquisition.

Those that advocate knowledge as a continuum endorse the view that "tacit knowledge and explicit knowledge are the poles of a knowledge spectrum" (Jasimuddin et al., 2005, p. 104), but they clarify that there is value in understanding the overlap between explicit and tacit knowledge. Chen, Snyman, and Sewdass (2005) make a great point that "the spiral that operates between tacit and explicit knowledge continually

effecting [sic] new knowledge among workgroups creates the energy and innovation that characterizes an active knowledge-intensive and knowledge-creating organization" (p. 6). This insight highlights the importance of studying tacit knowledge not only to understand how military personnel learn but also how new knowledge is created within a learning organization.

Focusing on individual learning and the continuum of explicit to tacit knowledge, consider a soldier skill like shooting an M16 rifle. According to the U.S. Department of the Army's Field Manual (FM) 3-22.9 (2008), *Rifle Marksmanship M16/M4 Series Weapons*, soldiers begin their training by learning the "firing fundamentals, which are taught in four phases—preliminary marksmanship instruction, downrange feedback, field firing, and advanced firing exercises" (p. 1-1).

In the first phase, soldiers are given a four-hour class where they learn the components of the weapon, how to assemble and disassemble the weapon, and how to clear it. They memorize the weight of the weapon (with/out a sling), the operational characteristics, and the maximum effective ranges. The knowledge acquired in the class is explicit knowledge about the facts of shooting, but it will not make someone a marksman, much less an expert.

The majority of learning to be a marksman occurs through actually holding and shooting the weapon. This is the tacit knowledge development that is personal and intuitive. Phases 2, 3, and 4 emphasize the importance of practice, feedback, and adjustments to shooting behaviors, as represented in figure 1 (on page 7).

Soldiers practice shot grouping, shooting from different distances and positions while receiving concrete feedback from the holes left on the targets and pointers from the coaches. Adjustments are made in posture, breathing, and trigger squeeze that result in improved performance. "When troubleshooting the fundamentals, the coach's imagination is the only limiting factor" (DA, 2008, p. 5-14).

Depending on the soldier's unit, advanced training may include moving targets, shoot houses, different terrain and weather conditions, and targets with friendly or enemy silhouettes. There may be more explicit knowledge integrated into the tacit knowledge by reading about advanced skills, receiving in class instruction from coaches, then adding advanced tacit knowledge through practice in simulated and live environments.

Learning to be an expert shot begins with concrete, explicit knowledge of the weapon, but the majority of the learning comes from the tacit knowledge from practice, feedback, and adjustments made while shooting. In summary, as stated by a soldier who has consistently achieved perfect scores on his qualification exams:

> To become an expert, the experimentation and feedback cycle is important in that it allows soldiers to control one's own learning, thus achieving more than they thought was possible, reinforcing and motivating them to do better, even hitting 40 out of 40 targets. (Specialist First Class W. O. Gray, personal communication, 26 September 2018)

In figure 1, the development of knowledge is depicted on a continuum from explicit to tacit where learning is iterative and integrated. It is important to note that the amount of explicit versus tacit knowledge needed to develop a skill may be different. Specifically, Mohajan (2016) estimates that "about 90% of the knowledge in any organization is embedded and synthesized in tacit form" (p. 10). Similar to our marksmanship example, only a small portion of the knowledge needed to become a marksman comes from the explicit knowledge learned from reading Army manuals

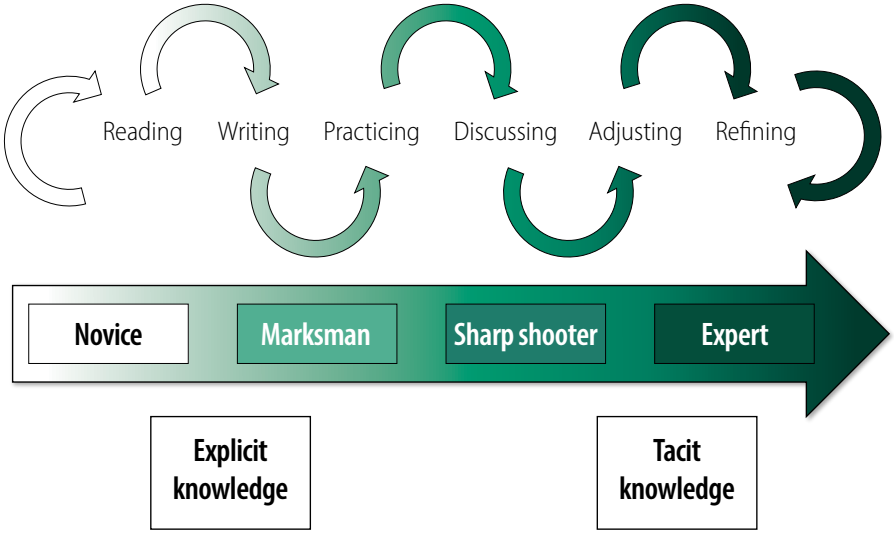

Figure 1. Continuum of explicit and tacit knowledge and the iterative process to become a marksmanship expert. Figure by authors.

and classroom instruction. The majority of learning relies on the acquisition of tacit knowledge through practicing, discussing, adjusting, and refining the shooting skills. So how can the Army ensure that soldiers receive the correct amount of explicit and tacit knowledge to become a marksman? How much more is needed to become a sharpshooter or an expert? What are the influencing factors that help or hinder the learning? Can any soldier become an expert, or are there aspects of the behavior that can't be learned, as posited by Polanyi (1966b)?

The first step to answering these questions is to recognize the importance of assessing the knowledge over time and identifying the requirements that are needed to establish when an individual has become an expert. For marksmanship, the Army has done a great job in establishing what it takes to become an expert (DA, 2008). Doctrine has identified concrete skills to measure and present many recommendations to improve performance. Other skills in the Army are

less well defined. For instance, hard skills like shooting are different than soft skills such as advising.

According to Brown (2018), "Current U.S. military doctrine identifies twenty-six personality traits that are desirable in advisors" (p. 1). Of the 26, he identified the five most important traits from his personal experiences as an advisor and trainer: empathetic, humble, visionary, diplomatic, and self-aware. Additionally, the Security Force Assistance doctrine (DA, 2009) identifies additional individual and collective skills that are required to be a good advisor. A sample of these skills presented in FM 3-07.1, *Security Force Assistance*, are: "communicate across cultures, build rapport, influence, and negotiate" (p. 7-4). These traits and skills are very nuanced and sophisticated. Further, it is the combination of the needed traits and skills together that result in the best advisors.

While advising is far more complex than marksmanship, the Army has spent much time and effort in identifying and training the needed knowledge, skills, and behaviors that are required to be a good advisor. But what about an expert advisor? According to Kauffman (2018), "initial coverage of the SFAB [Security Force Assistance Brigade] suggests that the curricula are still not comprehensive enough for our forces to operate successfully in the human domain" (p. 89). It is clear that there is more to be done to understand, cultivate, and transfer tacit knowledge of the softer skills required to win in a complex world.

Tacit Knowledge and Winning in a Complex World

A major reason underlying this gap in curriculum and training is the growing complexity of the operational environment. The Army's FM 3-0, *Operations*, states, "Army operations take place in the most complex of environments, on land among humans who have fundamental disagreements" (DA, 2017a, p. 1-4). Additionally, as described by Schatz, Fautua, Stodd, & Reitz (2017), "Globalization, ever-increasing computing power, and the proliferation of low-cost advanced technologies have created a level of worldwide complexity never before seen" (p. 78). This growing complexity makes military operations exceedingly difficult. To be successful in a volatile, uncertain, complex, and ambiguous environment, military personnel need to respond to enemy actions swiftly and completely (DA, 2017a). They need to learn quickly and act with confidence like an expert. If they have developed their job-related skills beyond explicit to tacit, they can respond quickly and effectively to any challenge presented to them, but the military needs to be sure they acquire that tacit knowledge.

At the organizational level, if the military is able to identify and tap into tacit knowledge across the enterprise, it can employ the talent more quickly and effectively. Additionally, if processes are in place and assessments are created, understanding how to accelerate tacit knowledge transfer could result in better training for future, yet unknown

skill sets. Specifically, Durant-Law (2003) states that by becoming a learning organization, a business is able to capture and explicate the tacit knowledge within its workforce. By using mechanisms that encourage employees to codify and share their tacit knowledge, companies will "operate on a higher plane, which allows it to predict outcomes, adapt to changing circumstances, and above all to be innovative" (Durant-Law, 2003, p. 1).

In many ways, the military does this already. After action reviews are a great example of codifying and sharing information about what worked or did not work after a mission. "Right seat rides" are formal activities that units use to transfer tacit knowledge from a unit on the ground to the unit that will be relieving them in place. Also, soldiers may develop continuity books to explicate the tacit knowledge that they acquired during their deployment to be shared with those replacing them for a smoother transition of roles and responsibilities. Unfortunately, when these and other methods are not used effectively, there is a great loss of institutional knowledge that cannot easily be reacquired (Şensoy, Keskin, & Orhan, 2015).

There are also many factors that influence learning in general that make the path to becoming an expert more challenging. The literature identifies numerous factors that influence learning, especially when considering adult learning. *The U.S. Army Learning Concept for Training and Education: 2020-2040* specifies six core principles of adult learning: "the learner's need to know; self-concept of the learner; prior experience of the learner; readiness to learn; orientation to learning; and motivation to learn" (DA, 2017b, p. 26).

For explicit information, like memorizing the characteristics of an M16, the soldier's need to know, prior experience, readiness to learn, and motivation to study will impact how well he or she will perform in the first hours of marksmanship training. Those factors also impact the development of tacit knowledge. The soldier needs to be motivated to practice the marksmanship behaviors, have strong self-awareness of his or her body to know the correct posture, breathing pattern, and trigger pull sensation, and be able to draw from previous experiences to fire effectively on a target.

Regarding tacit knowledge specifically, because of the experiential and personal nature of that learning, an important factor for effective acquisition of tacit knowledge is the feedback that is given when learning a skill. The feedback needs to be consistent, clear, and relevant to the learner. Effective feedback helps the learner know what "right looks like." The feedback also needs to be immediate so the learner can evaluate why his or her behavior hindered their performance and make the needed adjustments. The longer the delay between the actions and the feedback, the greater the likelihood that the learner will not be able to correct and, thus, improve his or her performance. The *U.S. Army Learning Concept* highlights the importance of providing feedback to students by including it in the analysis, design, development, implementation, and evaluation process for developing learning products to facilitate adult learning (DA, 2017b). Additionally, the *Army Learning Strategy* states that Army leaders should provide meaningful feedback and con-

sider delivery mechanisms that are "skillfully framed and appropriately delivered" (Army University, 2017, p. 12).

Another area of research that has focused on the factors that influence knowledge acquisition is the comparison of novice and expert performance. A major difference between a novice and an expert is how they look at a problem. A novice has little experience to rely upon so they must methodically and explicitly break down a problem and may struggle with what to focus on and what to ignore. An expert has both knowledge and experience to apply to a problem, seeing it in a more abstract way to visualize the larger picture and not be distracted by irrelevant information (Hinds, Patterson, & Pfeffer, 2001).

Charness, Krampe, Reingold, Tuffiash, & Vasyukova (2005) demonstrated that the single most important factor that predicted expert versus novice chess performance was deliberate practice. Players must "engage in several thousand hours of concentrated analysis and memorization of chess tactics and positions in order to build the knowledge base necessary to achieve regular success in highly competitive chess tournaments" (Charness et al., 2005, p. 163). The authors also indicated that expert chess players must self-regulate themselves during a tournament. This includes managing time effectively, avoiding distractions, and controlling negative emotions. From this research, explicit and tacit knowledge working together results in expert performance. It also highlights the importance of repetition (physically and mentally) and the emotional factors that can impact performance.

Confidence from repetitions of success and coming back from failure is also important to reaching expert levels, especially in difficult tasks. Unfortunately, overconfidence could have the opposite effect, where an individual does not take the time to consider the physical and emotional factors in play and lose his or her focus. Lastly, repetition reduces learning decay that can happen with perishable skills, like shooting effectively.

Measuring Explicit and Tacit Knowledge

Now that tacit knowledge has been defined and described and factors influencing military learning have been presented, the main question to be answered in this article, especially for the warfighter, is "How can explicit and tacit knowledge be measured?"

Explicit knowledge assessment is well known. These are the tools that are used in traditional classroom environments to assess student learning or on promotion boards to assess a soldier's comprehension of facts relevant to his or her job. These assessments range from basic true or false statements, to more complex scenario evaluations where how to do something well is easily communicated through written and verbal exams and easily graded using rubrics.

The effort to measure explicit knowledge is aided in part by the Army's adoption of Bloom's Taxonomy and the six cognitive levels (DA, 2013). The original taxonomy

was revised in 1956 and currently identifies the six cognitive dimensions as: remember, understand, apply, analyze, evaluate, and create (Krathwohl, 2002). The first level assesses an individual's ability to remember facts and recall information. The next level pertains to an individual's ability to explain the information, not just regurgitate the facts. The third level involves the application of the information in new, unique ways. This level appears to represent the overlap between explicit and tacit knowledge in that known facts, perhaps gained via explicit learning processes, are applied to different situations or problems based on previous experiences. The fourth level entails the ability to compare and contrast related situations or problems to develop a deeper level of understanding and thus facilitate the next level in decision making through evaluation. The sixth and final level is "creating." This is where the "new knowledge" is produced. Krathwohl (2002) defines the create level as "putting elements together to form a novel, coherent whole or make an original product" (p. 215).

Using Bloom's Taxonomy levels, the shooting analogy can be further dissected as an example of learning levels and related tacit knowledge development (see figure 2, page 12). At the first level of "remember," the soldier is able to remember the components of a M16, its weight, and the maximum effective ranges when shooting it. At the next level, the soldier demonstrates "understanding" by explaining how the weapon is constructed, how to set the sights, and the factors that influence hitting the target. Regarding "application," the third level, the soldier must demonstrate how his or her understanding of the mechanics of the weapon actually result in effective shooting. That is, he or she must physically apply the explicit knowledge and develop further his or her tacit knowledge through practice to qualify at the range. If challenged to hone their shooting skills at a higher level of analysis, the soldiers will experience shooting in different situations, different positions, and possibly using different weapons. This practice helps the soldiers develop more deeply their individual shooting behaviors (e.g., breathing, trigger squeeze, eye relief) by enhancing their tacit knowledge through practice. Unfortunately, practice by itself is not enough to become an expert shot. At the next level, "evaluation," the individual must check and critique his or her behavior (hopefully with the assistance of a knowledgeable coach providing actionable feedback). Without the quality feedback, continued practice may actually result in the development of bad habits reducing the likelihood that the individual will be able to become an expert shot. With the assistance of an expert qualified coach/mentor providing insights and feedback to the soldier, together they "create" new knowledge about how that individual can become an expert shot. This new knowledge can then be shared with others within the organization to help novices become expert shots.

By categorizing tacit knowledge into the levels of Bloom's Taxonomy, a method of measurement of tacit knowledge is also provided. That is, when a soldier's shooting skills are at the creation level, where he or she is creating new knowledge via developing enhanced techniques and procedures, it is known that they have maximized the acquisition of tacit knowledge. Whereas, at the application and evaluation levels, the

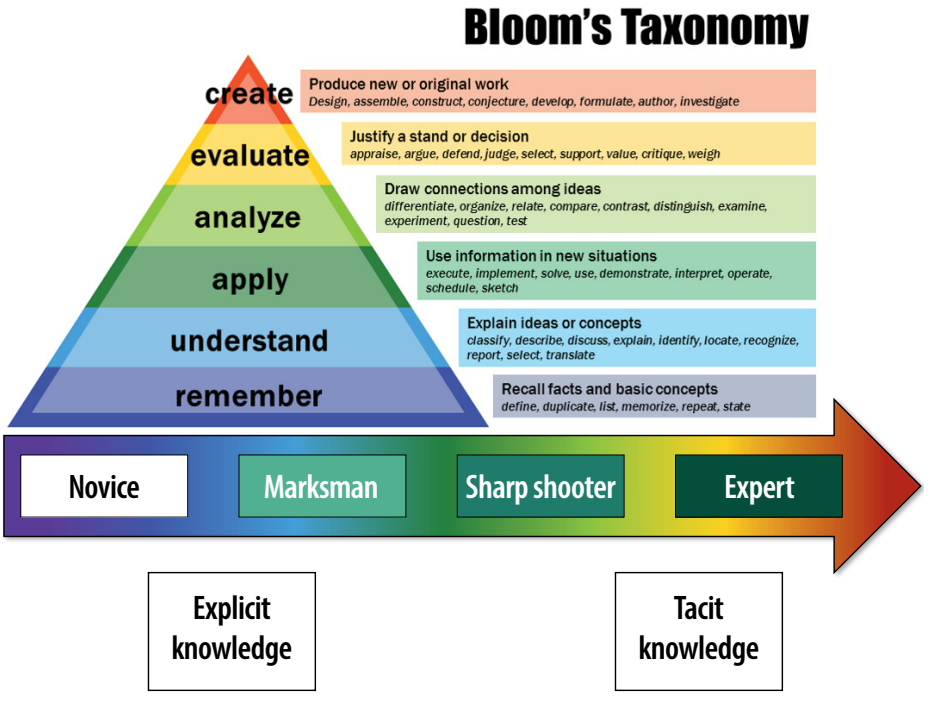

Figure 2. Continuum of explicit and tacit knowledge compared to Bloom's Taxonomy to depict steps to becoming an expert shot. Bloom's Taxonomy figure courtesy of Vanderbilt University Center for Teaching. Composite figure compiled by authors.

soldier is shooting well but has not yet created new knowledge that results in perfect shooting performance in any fighting situation.

Another approach to measuring tacit knowledge was developed by Robert Sternberg and colleagues (Antonakis, Hedlund, Pretz, & Sternberg, 2002; Cianciolo, Anotonakis, & Sternberg, 2001; Hedlund, Antonakis, & Sternberg, 2002; Hedlund et al., 1998; Horvath et al., 1994a, 1994b; Matthew, Cianciolo, & Sternberg, 2005; Sternberg et al., 1999). Unlike most of the other research assessing tacit knowledge, these efforts were specifically focused on a military population. It is for this reason, the authors will present the team's findings as a possible way forward for measuring military learning.

Sternberg and his team based their efforts on Sternberg's triarchic theory of intelligence, specifically related to his research on practical intelligence. This was a valid course of action because practical intelligence has been shown to encompass tacit knowledge (Wagner & Sternberg, 1985). To begin the research effort, Horvath, et al. (1994b) conducted an extensive literature review of tacit knowledge and military leadership. They divided tacit knowledge into three categories: (1) intrapersonal, (2)

interpersonal, and (3) organizational. Intrapersonal tacit knowledge consists of information about oneself—specifically, an individual's level of self-awareness, self-motivation, and self-organization. The interpersonal domain focuses on the knowledge about behaviors of other people. This would include an individual's ability to influence, cooperate with, and understand others. The organizational domain consists of behaviors related to the organization. The authors focused on how organizations optimize their work force, how they define the organization, and to what extent the organization has a vision for the future. The authors acknowledged that the categories are not mutually exclusive, but by creating the framework, they felt confident that tacit knowledge could be measured and used to predict job performance.

Horvath, et al. (1994a) continued the research by developing a tacit knowledge instrument to measure tacit knowledge in military leaders. The authors conducted semistructured interviews with 81 active duty Army officers from combat arms, combat support, and combat service support units. The interview data was coded and sorted for different examples of tacit knowledge used by Army leaders to address complex problems. Their findings indicated that for platoon leaders, these milestones included self-management and the establishment of credibility with others. For company commanders, these milestones included balancing company and battalion level interests. For battalion commanders, these milestones included managing organizational change and communication (Horvath et al., 1994b, p. vii).

The results provided the raw data used by follow-on research to further evaluate how tacit knowledge could be measured with military personnel. Horvath, et al. (1996) used the previous findings with additional survey data to create a model of tacit knowledge. In addition, several research products were developed by Horvath, et al. (1998) to be used in the work conducted by the research team and others from 1998 to 2008. They demonstrated that officers' and noncommissioned officers' tacit knowledge could be measured using sophisticated scenario instruments and correlated to other measures of leadership effectiveness, self-knowledge, and organizational culture (Taylor, Higley, & Grabarczyk, 2008).

Most relevant to this paper is the process used to develop valid measures of military personnel's tacit knowledge. The first step was to conduct interviews with a sample of the target population to extract stories and insights gained from job-related experiences. Horvath, et al. (1994a) included a sample interview protocol. The next step would be to conduct a content analysis of the raw data to establish examples of tacit knowledge, which can be sorted to create a category framework. Horvath, et al. (1996) included an example of several categories of tacit knowledge items such as: "dealing with poor performers," "establishing trust," and "managing the self" (p. 18). The categories were used to develop preliminary inventories. The inventories contained scenario-based questions where the participants rated the possible responses from "extremely bad" to "extremely good" based on what they would do in that situation. For example, Hedlund, et al. (1998) used the scenario, "You are a company commander with some

relatively junior lieutenants. Your goal is to develop these lieutenants. Rate the quality of the following strategies for achieving your goal" (p. B-18). Sample choices included: "Involve the lieutenants in every administrative action in the company"; "Involve the lieutenants only in those decisions that affect their platoons"; and "Tell the lieutenants when things in the battalion are bothering you" (p. B-18). Participant experiences and other demographic information were also collected to identify levels of job experience.

Additionally, subject-matter experts were used to establish the "expert" answers. This is generally done using survey data asking experts to rate the items on several dimensions. The results can be used to identify which items discriminate between experienced and novice answers. Lastly, the findings informed the final battery of measures of tacit knowledge that were used for follow-on research.

This process can be duplicated with a focus on any military learning environment to assess the explicit and tacit knowledge acquired. Further, research could ascertain the balance of explicit versus tacit knowledge needed to become an expert in specific military occupational specialties. For instance, to become a successful advisor, how much explicit knowledge is required before attending training at a combat training center where the tacit knowledge needs to be honed before deployment? Lastly, by understanding the needed explicit and tacit knowledge that must be acquired to become an expert in a particular skill, the military might be able to create new education and training programs that accelerate the knowledge transfer, making it more agile in meeting future fighting requirements.

Future Research

Other methods to measure knowledge transfer exist in the literature but are focused on nonmilitary populations. Future research should consider this literature and incorporate the methods, especially if they provide less complex, yet scientifically sound processes. Interestingly, the recommendations made by Schatz, et al. (2017) closely align with other ways to measure tacit knowledge using performance measures, competency models, maintaining robust data management systems, and collaborative learning approaches.

Numerous performance measures and competency models exist that could inform different ways of measuring tacit knowledge (MacLean, Kerr, & Qaseem, 2018; Russo, 2016; Stecher & Hamilton, 2014). There is also a growing body of literature investigating better ways of managing knowledge (Barley, Treem & Kuhn, 2017; Chen et al., 2005). In addition, there are several collaborative learning approaches, formal and informal, that the military could adopt or refine to further develop tacit knowledge. Some examples would be use of learning histories, whisper courses, sketch-noting, smart phone apps, game-based learning, mechanisms for remote team building, strategies to improve productive discourse, etc. Anything that can help explicate an individual's tacit knowledge transfer to others in a timely manner would benefit military readiness.

It is clear that military learning encompasses both explicit and tacit knowledge that to some extent can be known, measured, and shared across an enterprise. Additionally, effectively managing this knowledge throughout an organization facilitates improved institutional effectiveness, innovation, and resiliency (Mohajan, 2016, 2017).

In conclusion, the U.S. military has many of the pieces in place to successfully identify, measure, and transfer tacit knowledge throughout its organization but more work needs to be done. Stated eloquently by Schatz, et al. (2017), "The timing is right to unleash the full potential of our Human Dimension. All the resources are here—science, technology, and the demand—and all we need is a shared strategy and the will to pursue it" (p. 89).

Having discussed tacit knowledge in depth and argued that measurement is indeed possible, the authors would like to provide a few research questions for future study based on the hypothesis that identifying ways to accelerate tacit knowledge acquisition can improve Army readiness.

1. Does an increase in explicit knowledge acquisition before training and/or education events benefit the development of tacit knowledge? Thus, improving performance downrange?

2. How does motivation, self-awareness, and self-reflection impact tacit knowledge acquisition?

3. What are the ways to codify tacit knowledge into Army tactics, techniques, and procedures and lessons learned that lead to enterprise-level best practices that can be effectively managed and efficiently transferred across the organization?

4. How effective are collaborative learning techniques in increasing tacit knowledge transfer from experts to novices? Can these techniques improve observer, coach, and trainer feedback to students at training centers?

5. Can simulations improve tacit knowledge development, or are there limitations to what tacit knowledge can be gained from them? How much does the level of simulation fidelity matter?

6. At what point in education and training does practice reach its peak of effectiveness, and when do gains in developing tacit knowledge require real experience?

References

Antonakis, J., Hedlund, J., Pretz, J. E., & Sternberg, R. J. (2002). *Exploring the nature and acquisition of tacit knowledge for military leadership* (ARI Research Note 2002-04). Fort Belvoir, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Army University. (2017). *Army learning strategy*. Leavenworth, KS: Army University. Retrieved from https://armyu.army.mil/sites/default/files/documents/Army_Learning_Strategy_24_July_2017_(Signed).pdf

Barley, W. C., Treem, J. W., & Kuhn, T. R. (2017). Valuing multiple trajectories of knowledge: A critical review and research agenda for knowledge management research. *Academy of Management Annals, 12*(1), 278–317. doi:10.5465/annals.2016.0041

Brown, E. E. (2018). The definition of advisor: Comprehending the mission to advise foreign security forces. Small Wars Journal. Retrieved from https://smallwarsjournal.com/jrnl/art/definition-advisor-comprehending-mission-advise-foreign-security-forces

Charness, N., Krampe, R., Reingold, E. M., Tuffiash, M., & Vasyukova, E. (2005). The role of deliberate practice in chess expertise. *Applied Cognitive Psychology, 19*(2), 151–165. doi:10.1002/acp.1106

Chen, X. H., Snyman, M., & Sewdass, N. (2005). Interrelationship between document management, information management and knowledge management. *South African Journal of Information Management, 7*(3), 1–20. doi: 10.4102/sajim.v7i3.270

Cianciolo, A. T., Antonakis, J., & Sternberg, R. J. (2001). *Developing effective military leaders: Facilitating the acquisition of experience-based, tacit knowledge* (Annual Report). Fort Belvoir, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. Retrieved from https://apps.dtic.mil/dtic/tr/fulltext/u2/a400614.pdf

Collins, H. (2010). *Tacit & explicit knowledge*. Chicago, IL: University of Chicago Press.

Department of Defense. (2018). *Summary of the 2018 national defense strategy of the United States of America: Sharpening the American military's competitive edge*. Washington, DC: U.S. Government Publishing Office (GPO). Retrieved from https://dod.defense.gov/Portals/1/Documents/pubs/2018-National-Defense-Strategy-Summary.pdf

Durant-Law, G. (2003). *The tacit knowledge advantage.* Retrieved from http://www.durantlaw.info/sites/durantlaw.info/files/The%20Tacit%20Knowledge%20Advantage.pdf

Edmonson, A. C., Winslow, A. B., Bohmer, R. M. J., & Pisano, G. P. (2003). Learning how and learning what: Effects of tacit and codified knowledge on performance improvement following technology adoption. *Decision Sciences, 34*(2), 197–224.

Gerrard, B., & Lockett, A. (2018). Team-specific human capital and performance. *British Journal of Management, 29*(1), 10–25. doi:10.1111/1467-8551.12173

Hedlund, J., Antonakis, J., & Sternberg, R. J. (2002). *Tacit knowledge and practical intelligence: Understanding the lessons of experience* (ARI Research Note 2003-04). Fort Belvoir, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Hedlund, J., Horvath, J. A., Forsythe, G. B., Snook, S., Williams, W. M., Bullis, R. C., … Sternberg, R. J. (1998). *Tacit knowledge in military leadership: Evidence for construct validity* (Report No. 1080). Fort Belvoir, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Hinds, P. J., Patterson, M., & Pfeffer, J. (2001). Bothered by abstraction: The effect of expertise on knowledge transfer and subsequent novice performance. *Journal of Applied Psychology, 86*(6), 1232–1243.

Horvath, J. A., Forsythe, G. B., Sweeney, P. J., McNally, J. A., Wattendorf, J., Williams, W. M., & Sternberg, R. J. (1994a). *Tacit knowledge in military leadership: Evidence from officer interviews* (Report No. 1018). Fort Belvoir, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Horvath, J. A., Hedlund, J., Snook, S., Forsythe, G. B., & Sternberg, R. J. (1998). *Tacit knowledge in military leadership: Some research products and their applications to leadership development* (Report No. 1081). Fort Belvoir, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Horvath, J. A. , Sternberg, R. J., Forsythe, G. B., Sweeney, P. J., Bullis, R. C., Williams, W. M., & Dennis, M. (1996). *Tacit knowledge in military leadership: Supporting instrument development* (Report No. 1042). Fort Belvoir, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Horvath, J. A., Williams, W. M., Forsythe, G. B., Sweeney, P. J., Sternberg, R. J., McNally, J. A., & Wattendorf, J. A. (1994b). *Tacit knowledge in military leadership: A review of the literature* (Report No. 1017). Fort Belvoir, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Jasimuddin, S. M., & Klein, J. H., & Connell, C. (2005). The paradox of using tacit and explicit knowledge: Strategies to face dilemmas. *Management Decision, 43*(1), 102–112. doi:10.1108/00251740510572515

Kauffman, B. A. (2018). Preparing SFABs for the complexity of human interaction. *Military Review, 98*(4), 88–95. Retrieved from https://www.armyupress.army.mil/Portals/7/military-review/Archives/English/JA-18/Kauffman-Preparing-SFAB.pdf

Krathwohl, D. R. (2002). A revision of Bloom's Taxonomy: An overview. *Theory Into Practice, 41*(4), 212–237. Retrieved from http://cmapspublic2.ihmc.us/rid=1Q2PTM7HL-26LTFBX-9YN8/Krathwohl%202002.pdf

MacLean, C. H., Kerr, E. A., & Qaseem, A. (2018). Time out - charting a path for improving performance measurement. *The New England Journal of Medicine, 378*(19), 1757–1761. Retrieved from https://www.nejm.org/doi/pdf/10.1056/NEJMp1802595

Matthew, C. T., Cianciolo, A. T., & Sternberg, R. J. (2005). *Developing effective military leaders: Facilitating the acquisition of experience-based tacit knowledge* (Report No. 1161). Fort Belvoir, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Mládková, L. (2008). Work with tacit knowledge. *KSI Transaction on Knowledge Society: A publication of the Knowledge Society Institute, 1*(3): 66–67. Retrieved from http://www.tksi.org/JOURNAL-KSI/PAPER-PDF-2008/2008-3-1-15.pdf

Mohajan, H. K. (2016). Sharing tacit knowledge in organizations: A review. *American Journal of Computer Science and Engineering, 3*(2), 6–19. Retrieved from https://www.researchgate.net/publication/314062797_Sharing_of_Tacit_Knowledge_in_Organizations_A_Review

Mohajan, H. K. (2017). Tacit knowledge for the development of organizations. *ABC Journal of Advanced Research, 6*(1), 17–24. Retrieved from https://mpra.ub.uni-muenchen.de/83040/

Nash, R. C., & Magistad, E. P. (2010). Disarming the key leader engagement. *Military Review*, *90*(5), 11–20. Retrieved from https://www.armyupress.army.mil/Portals/7/military-review/Archives/English/MilitaryReview_20101031_art005.pdf

Nonaka, I. (1991). The knowledge-creating company. *Harvard Business Review*, 162–171. Retrieved at https://pdfs.semanticscholar.org/da2f/d9e368f14e0bb713fb6f4d7c32b0f72f6bcf.pdf

Polanyi, M. (1966a). The logic of tacit inference. *Philosophy*, *41*(155), 1–18. doi:10.1017/S0031819100066110

Polanyi, M. (1966b). *The tacit dimension*. Chicago, IL: University of Chicago Press.

Purković, D. (2018). *Conceptualization of technology as a curriculum framework of technology education*. Paper presented at the 7th International Scientific Conference: Technics and Informatics in Education, Čačak, Serbia.

Russo, D. (2016). *Competency measurement model.* Paper presented at the European Conference on Quality in Official Statistics, Madrid, Spain. Retrieved from http://www.ine.es/q2016/docs/q2016Final00276.pdf

Schatz, S., Fautua, D. T., Stodd, J., & Reitz, E. A. (2017). The changing face of military learning. *Journal of Military Learning, 1*(1), 78–91. Retrieved from https://www.armyupress.army.mil/Portals/7/journal-of-military-learning/Archives/jml-april-2017-Schatz-Fautua-Stodd-Reitz-Changing.pdf

Seidler-de Alwis, R., & Hartmann, E. (2008). The use of tacit knowledge within innovative companies: Knowledge management in innovative enterprises. *Journal of Knowledge Management, 12*(1), 133–147. doi:10.1108/13673270810852449

Şensoy, S. E., Keskin, A., & Orhan, M. E. (2015). Knowledge management in military organizations: Applications of knowledge creation and knowledge transfer. Paper presented at the International Conference on Military Security Studies, Turkish Army War College, Istanbul, Turkey. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.740.4199&rep=rep1&type=pdf

Stecher, B. M., & Hamilton, L. S. (2014). *Measuring hard-to-measure student competencies*. Santa Monica, CA: RAND Corporation. Retrieved from https://www.rand.org/pubs/research_reports/RR863.html

Sternberg, R. J., Forsythe, G. B., Horvath, J. A., Snook, S., Wagner, R. K., Hedlund, J., … Grigorenko, E. L. (1999). *Tacit knowledge in the workplace* (Report No. 1093). Fort Belvoir, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Taylor, T. Z., Higley, L., & Grabarczyk, D. (2008). *A U.S. Army Reserve (USAR) noncommissioned officer (NCO) tacit knowledge inventory: Flexible structure for squad-level leader self-development* (Research Product 2008-01). Fort Belvoir, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

U.S. Department of the Army. (2008). *Rifle marksmanship M16-/M4-series weapons* (Field Manual [FM] 3-22.9). Washington, DC: Government Printing Office [obsolete]. Superseded by Training Circular 3-22.9, *Rifle and carbine*, on May 2016. Retrieved from https://usacac.army.mil/sites/default/files/misc/doctrine/CDG/cdg_resources/manuals/fm/fm3_22x9.pdf

U.S. Department of the Army. (2009). *Security force assistance* (FM 3-07.1). Washington, DC: Government Printing Office [obsolete]. Superseded by FM 3-22, *Army support to security cooperation*, on 22 January 2013. Retrieved from https://usacac.army.mil/cac2/Repository/FM3071.pdf

U.S. Department of the Army. (2013). *Army educational processes* (Training and Doctrine Command [TRADOC] Pamphlet [TP] 350-70-7) [obsolete]. Revised 4 October 2018. Washington, DC: Government Printing Office. Retrieved from http://data.cape.army.mil/web/character-development-project/repository/tp350-70-7.pdf

U.S. Department of the Army. (2015a). *Techniques for effective knowledge management* (Army Techniques Publication 6-01.1). Washington, DC: U.S. GPO. Retrieved from http://www.eis.army.mil/uploaded_files/atp6_01x1.pdf

U.S. Department of the Army. (2015b). *Leader development* (FM 6-22). Washington, DC: U.S. GPO. Retrieved from http://www.milsci.ucsb.edu/sites/secure.lsit.ucsb.edu.mili.d7/files/sitefiles/fm6_22.pdf

U.S. Department of the Army. (2017a). *Operations* (FM 3-0). Washington, DC: U.S. GPO. Retrieved from https://armypubs.army.mil/epubs/DR_pubs/DR_a/pdf/web/ARN6687_FM%203-0%20C1%20Inc%20FINAL%20WEB.pdf

U.S. Department of the Army. (2017b). *The U.S. Army learning concept for training and education: 2020-2040* (TP 525-8-2). Washington, DC: U.S. GPO. Retrieved from https://adminpubs.tradoc.army.mil/pamphlets/TP525-8-2.pdf

Wagner, R. K., & Sternberg, R. J. (1985). Practical intelligence in the real-world pursuits: The role of tacit knowledge. *Journal of Personality and Social Psychology, 49*(2), 436–458.