Realistic Methods for Automated Coaching

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ABSTRACT

The battlefields of the 21st century will rely on versatile, adaptive leaders to achieve situational dominance in highly dynamic environments. Adaptive battlefield thinking is a complex cognitive task that requires commanders to monitor the unfolding tactical situation for unanticipated events, identify key characteristics of the situation, and to determine the proper actions in response. Ensuring effective training will require innovative methods. One very promising solution is focused, deliberate training in the area of adaptive battlefield thinking.

To meet the needs of the future battlefield, the Army has developed a theme-based Think Like a Commander training program. The training program utilizes eight themes of battlefield thinking that are thinking behaviors characteristic of high-level tactical experts. Evaluating the training during live, face-to-face instruction revealed significant performance gains even though the amount of time to perform the task was decreased with each exercise.

The training method relies on coaching to increases the rate at which participants can improve their performance and to reduce the possibility of negative training. Training in a distributed or an embedded environment will often occur without the benefit of a live instructor or coach. While instructorless coaching has been successful for procedural level skills, it presents a challenge for cognitive skills. To address this concern, the US Army Research Institute developed an instructorless version of the Think Like a Commander training program. The training uses an automated 3-dimentional coach to provide accurate, specific, timely, and useful feedback. This paper will examine how an automated 3-dimensional coach—that has been accepted by the training and military subject-matter-expert communities—can collect, process, and present timely feedback.

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Over the past decade the U.S. Army has identified an emerging need to train and develop leaders who are more adaptive and capable of responding effectively to a wide range of military operations. In addition to the need to develop training, there is a corresponding need to make training more deployable—or more accessible to leaders who are not stationed at the schoolhouse. To assist in meeting these needs, the U.S. Army Research Institute (ARI) for the Behavioral and Social Sciences established a number of research and development efforts to research innovative methods, techniques, and tools to train and develop adaptive performance. One of these is the Think Like a Commander (TLAC) program. The TLAC training is unique because it uses a deliberate practice methodology with expert coaching to train leaders on a cognitive behavior – thinking – using methods that have traditionally been applied to training more observable and measurable behaviors, e.g., rifle marksmanship, tank gunnery, and sports performance. In short, it does not greatly respect a traditional distinction between such things as physical movements, perceptions, and cognitions when it comes to training, rather it treats these all as behaviors that are amenable to the same training methods and principles. This paper will describe the training methodology and attempts to make the training more accessible to deployed leaders using distance learning (dL) technologies, intelligent tutoring systems, and three-dimensional (3D) animation.

Adaptive Thinking

The cognitive behavior to which our research effort has been applied is what has come to be called adaptive thinking by the U.S. Army. The term adaptive thinking, as we define it, describes the cognitive behavior of an individual who is confronted by unanticipated circumstances during the execution of a planned military operation. Adaptive thinking has been further defined as the ability to respond effectively to rapidly changing situations (Shadrick, Fultz, & Lussier, 2005). The skillful commander will, when performing adaptively, make adjustments within the context of the plan to either exploit the advantage or minimize the harm of the unanticipated event. This description of the adaptive thinking task defines the behavior in terms of the problem to be solved – to monitor the unfolding tactical situation for unanticipated events and to determine the proper actions in response to them. Another important aspect of the task involves the conditions under which it must be performed. The thinking that underlies battlefield decisions does not occur in isolation or in a calm reflective environment, it occurs in a very challenging environment. Commanders must think while performing: assessing the situation, scanning for new information, dealing with individuals under stress, monitoring progress of multiple activities of a complex plan. Multitudes of events compete for their attention.

Knowledge of the domain area is clearly an important requisite for performing the task well, but it is not sufficient. Typically U.S Army officers after years of study, both in the classroom and on their own, develop a good conceptual understanding of the elements of tactical decision-making. However, that knowledge alone, no matter how extensive, does not guarantee good adaptive thinking. Thinking is an active process that a commander does with his or her knowledge to come up with a better solution when facing a realistic decision point. As an example, if officers are told that the enemy has performed various actions on the battlefield and they are asked to infer the enemy's intent, they can generally do this fairly well depending on their understanding of the tactical domain. They have both the knowledge and the reasoning ability to solve the problem. Despite that, the same officers when placed in a demanding environment and required to perform as commanders will not necessarily display the behavior, i.e., develop a model of a thinking enemy and update that model based on continuing assessment of enemy actions. Expert adaptive thinking under stressful performance conditions requires considerable training and extensive practice in realistic tactical situations until thinking processes become largely automatic.

Habits, Automaticity, and Expertise

Habits develop only through performance. The more you repeat a behavior the more habitual it becomes, whether you want it to or not. This is true of

sensorimotor behaviors such as driving a car as well as cognitive behaviors. Most U.S. Army officers do not rise to a level of automaticity in battlefield thinking that permits high-quality adaptive thinking. It takes all their conscious attention to operate on the battlefield and to grasp the nature of what is happening; there are few resources left to think adaptively about the events.

Strong habits are such a critical component of expertise, in fact, that after one has attained some expertise, consciously thinking about habitual elements will usually degrade skilled performance. You cannot consciously control either thought or action with the same level of skill and complexity that you can learn to do them through repetition. Furthermore, stress narrows focus. Habits predominate in times of stress, fatigue, and competing demands for attention. Under such conditions people do what they have done most often; they do what comes automatically.

The cornerstone of developing expertise is the use of deliberate practice. A main tenet of the deliberate practice framework is that expert performance reflects extended periods of intense training and preparation (Ericsson, Krampe, & Tesch-Roemer, 1993). Describing the structure of deliberate practice activities, Ericsson et al. write "…subjects ideally should be given explicit instructions about the best method and be supervised by a teacher to allow individualized diagnosis of errors, informative feedback, and remedial training…. Deliberate practice is a highly structured aim; the specific goal of which is to improve performance. Specific tasks are invented to overcome weaknesses, and performance is carefully monitored to provide cues for ways to improve it further." (p. 367-8)

Traditionally the training of tactical thinking in the U.S. Army has not employed deliberate practice concepts. Instead, officers have been placed in realistic situations, supported by some form of live, constructive, or virtual simulation, and asked to perform in a whole-task environment to the best of their ability. The maxim "train as you fight" has risen to such a level of familiarity in the U.S. Army that the value of the notion goes almost unquestioned. Yet studies of the development of expertise clearly indicate that "as you fight" meaning performing in fully realistic simulated battles is neither the most effective nor efficient method of developing expertise. Such "performances" can help a novice become acquainted with applying military knowledge and can reinforce existing knowledge in an experienced person, but will not in and of themselves lead to the development of expertise. In many fields where expertise has been systematically studied, including chess, music and sports, development beyond intermediate level requires large amounts of deliberate practice (Ericsson, et al., 1993) and good coaching (Ericsson, 1996; Charness, Krampe & Mayr, 1996).

Coaching is an important part of training. A coach instructs the learner on the correct way to perform the tasks; letting novices 'figure it out' for themselves – especially in so complex a field as battle command – is very inefficient. Coaches observe performance and note discrepancies from expert form to guide where the learners must focus their attention and allows the learner to focus on areas of weakness. Coaching increases the rate at which participants can improve their performance and reduces the possibility of negative training, where participants become efficient at performing tasks the wrong way. Thus, a key component of effective training is the consistent and timely feedback an active coach provides to the individuals during training.

A Theme-Based Training Method for Battle Command Skills

We have asserted that you can train a cognitive skill, like battle command, in the same way you can train procedural skills. Recently it was discovered that even chess was trained in a similar way. For years, the Soviets dominated the chess world. The key to the Soviet chess training methods was that they trained the thinking processes of their students. The rest of the world studied the game of chess, its strategies and tactics, and tried to understand why one move was better than another and then they played a lot of games, both practice games and tournament games. In other words, the rest of the world acquired knowledge, practiced, and gained playing experience, but they did not actually train the skills.

The Soviets described principles of expert play which reflected the thought patterns of grandmasters. They created exercises that trained these principles, ingraining them in their students. *In short, the Soviets identified expert thought patterns - the cognitive behaviors displayed by top grandmasters – and then they deliberately trained those behaviors.* The Soviet students employed the expert thought patterns not simply because they understood the principles nor because they were following a remembered checklist. The behaviors had become automatic. As a result of the exercises, the students followed the principles without thinking about them, freeing their limited conscious resources to focus on the novel aspects of the contest and to think more deeply and creatively at the board. Thus, the Soviets had developed a number of training techniques for chess that incorporated many of

the features of deliberate practice training described above.

In recent years ARI has applied a similar strategy to deliberately train several complex cognitive skills – skills that had previously been left to Army officers to acquire through experience. One application of the method, the Think Like a Commander (TLAC), trains adaptive thinking in tactical situations at the company command level.

A key step to the training method is to develop a list of what are called themes – they are cognitive behaviors, i.e., patterns of thought, that are characteristic of experts in the performance of the task at hand. In our applications we have used about 8-10 themes. As examples, some themes of tactical thinking are Model a Thinking Enemy and Consider Timing Explicitly. The themes need to be behavioral, albeit cognitive behaviors, that are at the right level of generality – neither too general nor too specific. By way of illustration, a very general thinking skill, which is applicable to a wide variety of situations, could be phrased "take a different perspective." A more specific instance, tailored to battlefield situations would be embodied in a rule such as "if the enemy does something you didn't expect, ask yourself what purpose he hopes to achieve by the act," a behavior that inclines one to take the enemy perspective. A yet more specific instance would be "when you see an enemy-emplaced obstacle, ask yourself why he put it in that exact location and what he intends to achieve by it." Recall that these thought acts – these cognitive behaviors – are not part of a large checklist that one continually seeks to proactively apply to the environment, rather they are thought habits that operate within complex structures (i.e., mental models) and must be triggered by some stimulus event. When the triggering event is very specific and identifiable, such as an enemy-emplaced obstacle, the training may proceed readily but has a limited applicability. Achieving the desired effect of improving adaptive thinking in tactical situations would require an enormous number of such habits be trained. At the other end of the spectrum, the mandate to "take a different perspective" is so vaguely triggered – and the act of taking the different perspective so broadly flexible – that a tremendous and thoroughgoing training effort must be required to achieve any lasting effect, especially when one considers the attention-demanding and focus-narrowing environment in which we seek to affect behavior. Thus, we believe the course taken in this effort to be the most efficacious one; to place the themes at the right level of generality that they represent thinking behaviors that are as specific as possible while remaining relatively consistent over a wide range of tactical situations. Because of that consistency, the formation of automatic thought habits will occur more quickly, and because of the specificity they will more likely operate in the desired conditions. Both factors facilitate the best transfer of training.

Once the behaviors to be trained are identified, training can proceed efficiently using well-established principles of training. Specific problem cases are presented, learners are asked to perform and record their solutions, instructors demonstrate appropriate thought patterns, students score themselves against prepared expert responses, and the process is repeated until student performance levels increase. More information on the themes and their development can be obtained from Lussier, Shadrick, & Prevou (2004).

The Think Like a Commander Training

This section briefly describes the design of the TLAC training product. The central component of the training is a set of vignettes based on tactical situations drawn from a single overarching scenario. Each vignette begins with a short—typically two to five minutes in duration—audio-video file that presents the tactical situation. The vignettes provide the learner with the opportunity to apply the behavioral themes to their thinking process.

While each vignette has no officially sanctioned solution, each does have a set of unique "indicators" that represent important considerations of expert battlefield commanders. These are the elements of the situation—the key features—that should play a role in the decision maker's thinking. For each vignette, about 16 such indicators were determined. While the themes are consistent across all vignettes, each vignette has unique indicators that represent what an expert commander should consider in that specific vignette situation if he or she were to engage in the thinking behavior represented by the theme.

Once the presentation of the vignette is completed, the student is asked to think about the situation presented and to list items that should be considered before making a decision. The student does this by thinking about the problem, identifying the critical aspects of the situation, and creating a list of the important elements. Over time, the instructor decreases the amount of time students are allowed, forcing them to adapt to increased time pressure. After each student completes his or her list, the instructor leads a class discussion. Class members discuss the second- and third-order effects related to actions students suggest. Students are encouraged or required to discuss and/or defend

considerations relevant to the vignette. The coaching allows the student to understand how experts would have addressed the problem. Such coaching by a subject-matter expert is a key part of the learning process to enable the student to develop expert habits.

In the final phase of each vignette, the students see the list of considerations that experts believed were important, along with the list they initially made, and they mark the indicators they have in common with the experts. Once the students rate their performances, they are given feedback linked to the general themes, (e.g., 25% for the 'Model a Thinking Enemy' theme). This individual feedback supplements and complements the feedback given by the instructor during the class discussion phase of the training. The students are then able to focus their future thinking on subsequent vignettes and place additional attention on themes for which they scored low.

A key component of the training in the expert feedback the student receives from the coach. In traditional face-to-face classroom situations, coaching can easily be accomplished by having an instructor provide the expert mentoring that is needed to bring student performance to a desired level. However, how can coaching be provided when the coach and students are located in different places? Or, when a coach is not available?

Distance Learning

Distance learning technologies can potentially offer a suitable way to provide coaching at a distance. Our first attempt of providing coaching during dL environments was initiated with our goal to adapt the TLAC training to web-based format. This goal was directly related to the ARI mission to develop innovative methods and strategies to train and develop the Future Force, in particular to provide the scientific basis for effective embedded training (ET) technologies.

The original TLAC (classroom version) training application was designed as a stand-alone program that ran on student computers. All necessary software for presenting vignettes and collecting student data was contained on each student's computer. During the training, individual student responses collected during the execution of a TLAC vignette were saved to a network where they were combined for analysis. While this methodology works reasonably well in a schoolhouse environment, it is impractical when students are geographically dispersed. *Think Like a Commander – Distance Learning* (TLAC-dL) was designed for students who are not co-located and will require remote presentation of vignette materials, remote interaction, data collection, coaching, and feedback. Thus, the TLAC-dL method is analogous to an interactive-multimedia-instruction approach implemented in an ET system. Just as in the stand-alone version, students view a vignette after which they respond to the situation by listing key tactical considerations of the vignette. Then there is coaching/mentoring by an instructor, after which, the students score their performance and receive feedback based on the themes. The two key differences between TLAC in the classroom and TLAC-dL are that the presentation of the TLAC-dL materials occurred over the Internet, and the coaching must be presented in a distributed manner.

In TLAC-dL the students accessed the materials using a standard web browser. Benefits of this approach are that materials can be easy updated to reflect current training needs or new lessons learned and tools, techniques, and procedures, and it is easy to add new materials specific to the current environment or operation. Training in a dL environment requires that coaching, however, occurs in the context of distributed training – it will be conducted at a distance without the benefit of face-to-face interactions. This represents a potential weakness of the method because coaching is such a critical component of the training.

Current technology allows for a variety of coaching techniques in dL environments varying from no coaching at all to a close simulation of a classroom environment. During the evaluation of the TLAC-dL methodology, three methods of distributed coaching were assessed and compared to standard face-to-face coaching. The three methods were: an instructorless, an asynchronous, and a synchronous method.

The instructorless condition was the equivalent of using a multi-media self-help book. It used stand-alone or local area network resources to allow viewing of the presentation of vignette materials. The student generated their list of responses and then viewed model feedback materials. In the instructorless condition students read a doctrinally-based solution using written text. Although the Instructorless condition lacked an active interchange of ideas, it had the advantage that feedback was presented immediately.

The asynchronous method represents an approach that is more tailored to the individual student responses. Specifically, after the students viewed the vignette presentation and provided their responses, their output was electronically sent to an expert coach who

provided feedback remotely via email. The feedback process required several hours or even overnight, but it was tailored to the individual student.

The third method, the synchronous method, provided a close simulation of a classroom environment. At a scheduled time after viewing a vignette and submitting responses, students engaged in a mentored discussion of the vignette using the Virtual Tactical Operations Center—an on-line collaborative environment providing functions such as chat, whiteboard, and voice over internet. All students viewed/listened to other students' comments as well as the comments of the expert coach, allowing feedback that was both tailored and timely.

The results indicated that selection of a coaching method has an effect on performance. The synchronous coaching and feedback method was the best choice for distance learning applications. The synchronous method provided the students with a knowledgeable instructor and timely feedback. It is important to note that the method was the best even though there were technical issues involved with the specific collaborative software used during the study. While the synchronous form of coaching was almost as effective as face-to-face coaching, it still required a live coach.

At times, it may not be possible to obtain feedback from a live coach. Therefore, there may be times when feedback will have to be provided by instructorless means. While not ideal, results from our study indicate that instructorless training may be an effective and viable option. Our first attempt at providing instructorless feedback consisted of written text that the student was required to read. Such feedback was easy to prepare but not ideal. As a result, we looked to develop a better way to present feedback in an instructorless training environment.

An Automated Coaching Method

As the U.S. Army has implemented the theme-based training method described in the previous sections, they rely to a large extent on a live instructor. Even our successful attempt in develop a dL version of the training required a live instructor in a synchronous, distributed environment. However, the synchronous dL approach still does not support training in environments where there is no access to an expert coach.

We conducted a series of experiments designed to develop instructorless versions of the training. Several attempts at developing intelligent tutoring solutions proved to be of only limited success (cf. Domeshek, 2002; Lochbaum & Streeter, 2002; Domeshek, 2004; Ryder et al., 2004). We could with significant effort construct some systems that seemed to work, at least to a small degree, in the laboratory – but we could by no means convince ourselves that artificial intelligence would provide a feasible solution in the real world of future Army training, especially for hard-to-train battle command skills like adaptive thinking. For highly proceduralized tasks, especially those that involve system operation, expert system technology might be possible. But even there, the costs to build and update training could well be prohibitive for most ordinary Army training applications. We believe the impact of artificial intelligence in supporting cognitive training is often greatly overestimated. The cost of developing intelligent tutoring systems and the inability of the systems to provide realistic and expert coaching led us to investigate more realistic methods for providing instructorless coaching.

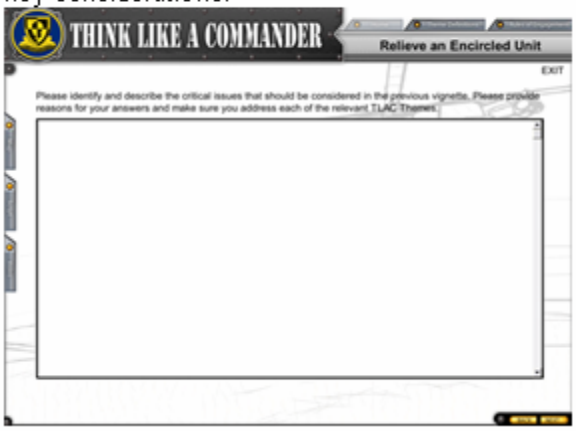
From our research, we determined that the best way of providing instructorless coaching was to abandon the complexities of artificial intelligence and produced a coaching method that was limited in interactivity but was able to provide compelling feedback. Once the student has attempted to solve the problems presented in the vignette—by typing in the critical information—the instructor's discussion is replaced by a discussion among computer animated characters that represent key figures in the vignette. They present key learning points in the operation and demonstrate the thinking processes of tactical experts. From time to time, the animated characters ask the students questions and then provide keys to allow the students to score their responses. At the end, the student has a set of scores and feedback similar to that in the instructor-facilitated training. The format presents new ways of visualizing the situation and allows for deeper interaction between students and computers (cf. Aldrich, 2005). Figure 1 describes the entire training process using the instructorless training methodology.

While the research to compare the effectiveness of this instructorless method to the instructor-led method is currently ongoing, our initial exemplar of the training was quickly accepted by the military training community. In partnership with the U.S. Army Armor School and Center, the training is being implemented in the Armor Captains Career Course and the training will be used in the newly developed Maneuver Captains Career Course. In addition, Brigade Combat Teams of the 10th Mountain Division, 82nd Airborne Division, and the 7th Infantry Division have also conducted unit training sessions with the training.

1. Student received training on the expert Themes of Battlefield Thinking and reviews and example.

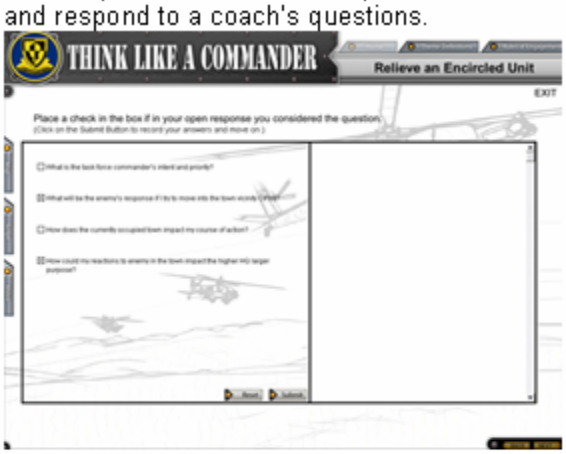
2. Students view and a 3-5 minute theme-based vignette that presents a complex and rapidly changing tactical situation.

3. Students are then asked apply their tactical knowledge to think adaptively and list their key considerations.



4. Students then view a 3D coach discussing expert considerations pertaining to each of the battlefield thinking skills.

5. The students are prompted to evaluate their response based on an expert solution and respond to a coach's questions.



6. After covering each of the eight themes, the student is provided feedback to his or her responses.

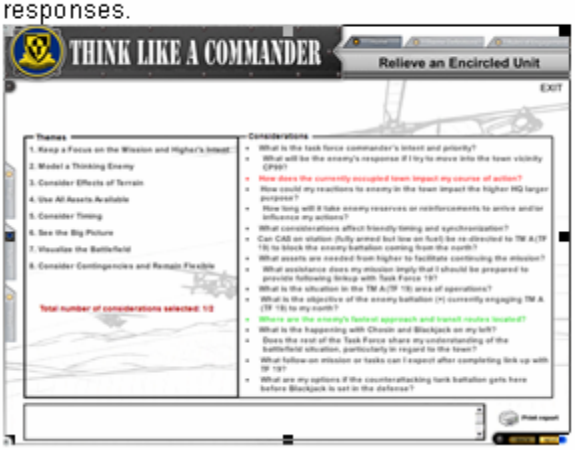


Figure 1. **Captains in Command training process.**

An example of the method of automated coaching is shown in Figure 2. The example portrays part of the conversation between the coach and the main actor in the vignette. In the example, the coach discusses specific information related to one of the eight TLAC themes. Next, the 'camera' zooms in on the coach's face and the coach ask a specific question of the student and the training system provides an area for the student to respond. After the student provides a response, the scene continues with more discussion between the main actor and the coach. More information is available in Wilson, Holder, Kiser, Fullen, Hobson, and Shadrick (2006).

Coach: That's a great point. The checkpoint should be positioned to maximize 'passive' measures to control movement in and around the checkpoint. Make sure it is visible and located where traffic cannot turn back, get off the road, or bypass the checkpoint without being observed. [Zoom in on Coach's face] Captain, what other physical measures can you think of that might help prevent similar incidents in the future?

<< Student response to the coach's question.>>

CPT Baker: Sir, in a broad sense, does this checkpoint control the area intended? The directions of streets, their intersections and overlooking buildings all control local areas and should be considered. In the case of checkpoints in an urban area like this, it may be possible to block off streets with debris and only occupy a limited number of vehicle entry/exit points. Then we could focus our attention on observing pedestrian activity.

***Figure 2*. An example from the instructorless tactical training package.**

The team that worked on developing the Captains in Command training program included an instructional designer, an experienced SME, a media specialist, and two 3D modelers. The modelers used several software packages to develop the coaching sessions, including: 3D Max (character animations); Vue Infinite (Landscape software); Sony Sound Forge (audio editing); Voice-O-Matic plug-in (lip synching); and Adobe After Effects (compositing and final rendering). The final product is an affordable solution to providing instructorless coaching. The program is currently distributed on two DVDs and is being adapted to support Internet delivery of the training.

Measurement of Adaptive Thinking

The theme-based training method discussed in this paper is unusual in that it intends to deliberately train cognitive as opposed to sensorimotor behaviors. It is being fielded at a rapid rate to a number of U.S. Army schools and units, including the U.S. Army Armor School, which provides training to officers deployed to Iraq and Afghanistan and other locations. Most significantly, it has produced surprisingly strong performance gains as measured by the ability of Army officers to identify significant features of complex tactical situations under increasingly severe time constraints.

Some recent data, using the training vignettes as performance measures, provide validation for our training and our measurement method. One-hundred and forty-two U.S. Army officers (lieutenant thru lieutenant colonel) completed three challenging and dynamic tactical problems. The results are shown in Figure 3. Officers with deployments to Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF) performed significantly better on the adaptive thinking task. The data support recent reports (e.g., Wong, 2004) that suggest that events in OIF and OEF are contributing to the development of agile, adaptive leaders.

Performance differences were also obtained for officers of various levels of rank. In examining results for non-deployed officers, the results clearly demonstrated that performance on the adaptive thinking task increased with higher rank. The results for deployed officers demonstrated performance improvement for deployed captains, majors, and lieutenants colonels. Further, the results showed that the performance of deployed captains and majors converged with that of the lieutenant colonels. The analysis revealed that there was no difference in performance between deployed and non-deployed lieutenants

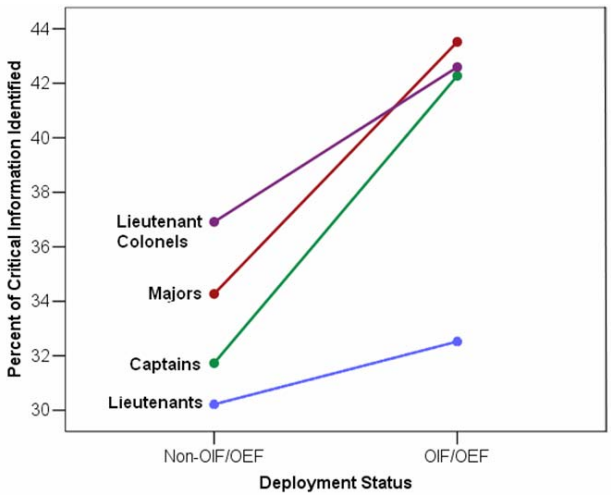


Figure 3. **Mean Percent of Critical Information Identified for each Rank by Deployment.**

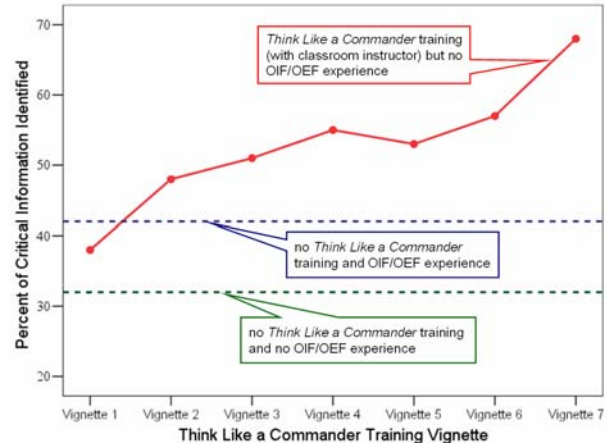


Figure 4. **Illustration of the value of adaptive thinking training for captains.**

However, what is also particularly relevant (See Figure 4) is that when captains with OIF/OEF experience but no tactical adaptive thinking training were compared with captains with training but no OIF or OEF deployment experience on a series of vignettes, the scores looked to be the same initially. Continued training led to substantially higher performance scores than those we believe attainable by captains with only deployment experience. In fact, the captains with our training (who had not been deployed in either OIF or OEF) outscored even lieutenant colonels with OIF/OEF deployment but no adaptive thinking training. Here we are comparing the effects of approximately 10 hours of training to an entire deployment. Note of course that we are not claiming that we measure all that is learned during a deployment, but it is some hard evidence of accelerated learning in this domain. The main point is that the experiential learning in a realistic or even a real environment can be very slow compared to deliberate focused training such as Think Like a Commander.

Additional research efforts are needed to determine the effectiveness of the instructorless approach to the face-to-face version of the training. In addition, an additional effort is required to allow the training to be accessed using a standard web browser. Ongoing research in collecting data similar to those presented in figures 3 and 4 for the instructorless method described in this paper. This data will be compared to the results obtained using a live, face-to-face instructor to provide feedback.

A significant point must be made regarding the use of instructorless feedback. The successful use of instructorless feedback, or any feedback, was a direct result of the focus on expert behaviors and key characteristics of the training. By clearly identifying the expected performance behaviors and outcomes measures feedback was developed to model student performance. It is the focus on behaviors and performance measurement that separates training from practice or discovery learning.

REFERENCES

Aldrich, C. (2005). *Learning by doing: A comprehensive guide to simulations, computer games, and pedagogy on e-learning and other educational experiences*. San Francisco, CA: John Wiley & Sons.

Chaness, N., Krampe, R., & Mayr, U. (1996). The role of practice and coaching in Entrepreneurial Skill Domains: An International Comparison of Life-Span Chess Skill Acquisition. In K. A. Ericsson (Ed.), *The Road to Excellence*. (pp. 51-80). Mahwah, NJ: Erlbaum Associates.

Domeshek, E. A. (2002). *Intelligent tutoring system for teaching battlefield command reasoning skills* (ARI Technical Report 1124). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Domeshek, E. A. (2004). *Phase II final report on an intelligent tutoring system for teaching battlefield command reasoning skills* (ARI

Technical Report 1143). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Ericsson, K. A. (1996). The Acquisition of Expert Performance. In K. A. Ericsson (Ed.), *The Road to Excellence*. (pp. 1-50). Mahwah, NJ: Erlbaum Associates.

Ericsson, K. A., Krampe, R., & Tesch-Römer, C. (1993). The Role of Deliberate Practice in the Acquisition of Expert Performance. *Psychological Review, 100*, (3), 363-406.

Lochbaum, K. E., & Streeter, L. A. (2002). *Carnegie Hall: An intelligent tutor for command-reasoning practice based on latent semantic analysis* (ARI RN-2002-18). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Ryder, J. M, Graesser, A. C., LeMentec, J. C., Louwerse, M. M., Karnavat, A., Popp E. A., & Hu, X. *A dialog-based intelligent tutoring system for practicing battle command reasoning* (ARI Technical Report, 2004) Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Shadrick, S. B., Fultz, C., & Lussier, J. W. (2005). *Measurement of Adaptive Thinking Gains in Operation Iraqi Freedom And Operation Enduring Freedom Leaders*. (ARI Research Report) Alexandria, VA: U.S. Army Research Institute for the Behavior and Social Sciences.

Lussier, J. W., Shadrick, S. B., & Prevou, M. I. (2003*). Think Like a Commander prototype: Instructor's guide to adaptive thinking* (ARI Research Product 2003-01). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Wilson, B. E., Holder, D. Kiser, R. D., Fullen, T. Hobson, R, & Shadrick, S. B. (2006). *Captains in Command*. (ARI Research Product 2006-04) Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Wong, L. (2004). *Developing adaptive leaders: The crucible experience of Operation Iraqi Freedom.* Carlisle Barracks, PA: Strategic Studies Institute of the U.S. Army War College.