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The current methods of developing officers to be innovative problem solvers are inadequate. This problem is exacerbated by the complexity of the current operating environment and the requirement for joint operations. The operational level staffs require officers that are capable of developing innovative solutions to new and radically more complex problems. This problem solving capability can not be trained by the use of rote memorization of planning processes and doctrine. This capability can be trained by making Critical Thinking the focus of officer

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NAVAL WAR COLLEGE
Newport, R.I.

Critical Thinking and the Development of

Innovative Problem Solvers

by

Christopher T. Drew
MAJ   U.S. Army

A paper submitted to the Faculty of the Naval War College in partial satisfaction of the requirements of the Department of Joint Maritime Operations.

The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Navy.

Signature: _____

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Abstract

AUTHOR: MAJ Christopher T. Drew

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The current methods of developing officers to be innovative problem solvers are inadequate. This problem is exacerbated by the complexity of the current operating environment and the requirement for joint operations. The operational level staffs require officers that are capable of developing innovative solutions to new and radically more complex problems. This problem solving capability can not be trained by the use of rote memorization of planning processes and doctrine. This capability can be trained by making Critical Thinking the focus of officer education.

Critical Thinking is the general cognitive skill of developing the best solution when there is not a single correct answer. It consists of two key elements, the development of a solution and then a meta-cognitive process of examining the reasoning behind the solution. This meta-cognitive process when evaluated and corrected helps the students develop better solutions by being better thinkers. Integrating the evaluation of the reasoning is the critical piece that must be used in officer development.

Integrating critical thinking into officer development requires the shifting of knowledge focused classes to self-study, teaching and using argument/concept mapping to reveal student's reasoning, and using the Universal Intellectual Standards as the basis of feedback on their reasoning.

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"The highest art of operational leadership is to make timely and sound decisions. The larger perspective at the operational level requires a more complex and challenging decision-making process than at the tactical level."[1]

Introduction

Our country is at war and the need for officers that can solve complex problems at the operational level is growing. Our current method of developing innovative problem-solvers is inadequate. There is no quick solution, but there is a solution. Innovative problem-solving officers can be developed by implementing a program of institutional and professional development incorporating Critical Thinking training and by using the Universal Intellectual Standards as the basis for feedback. The current method of getting innovative officers is to depend on Darwinism – those officers that self-develop this capability, if in the right environment, will be promoted. While the officers with potential, but have not been trained, will be disadvantaged. This is short sighted and wasteful and will not provide the quantity of innovative officers needed. Critical Thinking is the general cognitive skill of determining the best answer when there is not one correct answer. [2] Critical Thinking is a trainable skill and because expertise in this skill enables innovative problem-solvers it should be the focus of officer education. Finally, the use of the Universal Intellectual Standards as a basis of feedback better addresses the complexity of today's problems and reduces the inherent limitations of traditional feedback mechanisms. Just as the military embraces transformation to align future systems and capabilities with the contemporary operating environment, it can not afford to fail in transforming how we educate our officers to solve the future problems.

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[1] Vego, Milan N., Operational Warfare (Newport, RI, U.S. Naval War College, 2000), 603.

[2] van Gelder, Tim, "How to Improve Critical Thinking Using Educational Technology," 2001, < http://www.philosophy.unimelb.edu.au/reason/papers/ASCILITE2001.pdf> [15 December 2004].

Current Professional Development Shortfalls

Before looking at how we should transform officer professional development, it is necessary to examine the shortfalls in the current systems. Officer education is generally defined as a three part system that includes institutional, operational and self-development components. This system fails because the instructional methodologies and curriculums are based on antiquated and flawed concepts of learning, the instructors are rarely effectively resourced and trained, and its' components are typically focused on non-transferable declarative knowledge at the tactical level. The flaws of the current systems of professional development limit the effectiveness of deliberately producing innovative problem-solvers at the operational level.

Shortfalls - Flawed Concepts of Learning

The first key limitation is an incomplete and flawed understanding of the concepts of learning. These misunderstandings drive ineffective instructional methodologies and poorly designed curriculums. Significant research has been conducted on cognitive skill acquisition. Though, as with any field of study, there are disagreements on particulars, there are some essential ideas that are accepted as truth. These broad truths reveal the limitations of current military education. There are three areas of misunderstanding – linking, time to learn cognitive skills and transference of skills. Each of these contributes to ineffective curriculums and instruction.

Flaws - Linking

The first misunderstanding is in regards to the concept of linking. This means that if we teach the parts of a process then the student can independently link the parts and

effectively execute the whole.[3] Military curriculums tend to embrace this concept. For example, teaching decision making typically takes the form of describing the individual steps, having the students perform elements of each step and then either testing or expecting the students to execute the entire process. Evidence shows that this linking rarely occurs. [4] Since linking can not be counted on, the instructional design of most of the military's educational programs is flawed. These flawed designs are compounded by the lack of understanding of the time requirements to learn complex cognitive skills.

Flaws - Time Required to Learn and Master Cognitive Skills

The second problem deals with the length of time required to learn and master cognitive skills. Research done by John R. Anderson, sponsored by the Office of Naval Research indicates that it takes a minimum of 100-hours of learning and practice to gain any level of proficiency in a cognitive skill.[5] Expertise or mastery of a complex skill requires continual practice. Research shows that across multiple fields, the highest level of expertise requires about 10-years of practice.[6] In practice this means that the military's practice of teaching for the next job rarely produces a qualified officer. What happens in actual execution is that the officer achieves baseline proficiency at about the same time they are reassigned. Expertise eludes most officers unless they stay in the job for extended periods or

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[3]van Merrienboer, Jeroen J. G., "Blueprints for Complex Learning: The 4C/ID-Model," 2002, <http://www.ou.nl/info-alg-english-r_d/OTEC_research/publications/Jeroen%20van%20Merrienboer/Jeroen%20vanMerrienboer%20etrd.pdf> [5 December 2004], 2.

[4] Ibid, 2.

[5] Anderson, John R., "Acquisition of Cognitive Skill," Psychological Review, 89 (1982),369.

[6] van Gelder, Tim, "Teaching Critical Thinking, Some Lessons from Cognitive Science," 2005,<http://www.philosophy.unimelb.edu.au/reason/papers/Teaching_CT_Lessons.pdf> [6 January 2005], 3.

have the same job in each assignment.[7] Reassignment of officers to new jobs is linked to the

third major misconception, transference of skills.

Flaws - Transference

The ability of officers to transfer skills learned for one situation to another is

depended on for maintaining a broad base of generalist officers. The problem is that

transference occurs less frequently then assumed.[8] For the joint community this is a

significant issue. It means that we cannot assume that the expert at solving problems

involving maritime elements will be able to transfer his skill to land problems. This scarcity

of transference compounds the problem of developing effective curriculums. An increased

probability of skill transfer is possible, but it requires a more complex instructional

environment.[9] This means that the skills of tactical or technical problem-solving can only be

transferred to operational problem-solving if the instructional design is crafted to teach

transference. Transference can and does happen, but it requires a greater variation in the

training materials and this can exceed the focus of the program and can exceed the

capabilities of the instructors.

Shortfalls - Training Instructors

The second key limitation is the training and resourcing of instructors. Instructing is

a complex cognitive skill, yet most military instructors are assumed to be able to teach

because of their qualifications in the subject area.[10] In addition to teaching responsibilities,

these instructors are usually tasked with developing, maintaining or supporting the

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[7] Expertise is identifiable in some of our senior enlisted and warrant officers that have been doing the same job for 10 or more years.

[8] van Gelder, Tim "Teaching Critical Thinking, Some Lessons from Cognitive Science," 3,

[9] Riedel, Sharon L. ed., "Training Critical Thinking Skills for Battle Command," Army Research Institute Workshop Proceedings, Fort Leavenworth, KS, Army Research Institute, 2000, pg 28.

[10] Some military schools utilize Permanent Military Professor – officers that have elected to remain in the academic environment. The United States Military Academy and the U.S. Army War College have some.

development of the curriculum. In the U.S. Army, schools are resourced with instructors based on the number of teaching hours. This means that the time spent on curriculum development and preparation to teach is not resourced. Given the manpower requirements in the operational units, each service struggles to fully resource instructional institutions. The effect is that curriculums are frequently developed to be easily maintained while meeting the basic learning objectives. This tendency results in the third key limitation, curriculums being focused on declarative knowledge.

Shortfalls - Focus on Declarative Knowledge

The third key limitation of the current systems is the overwhelming focus on declarative knowledge. Declarative knowledge is knowing what to do.[11] It is typified by lecture type instruction, a requirement for rote memorization of facts and process sequences, and evaluation by multiple-choice and fill-in-the-blank exams. In terms of Bloom's Taxonomy[12], this focus on declarative knowledge means that the goal of most military education is the lowest levels of cognitive development – knowledge and comprehension (see appendix 1). Even the more advanced programs struggle to include the higher goals of learning: application, analysis, synthesis and evaluation. This limitation can result in three educational problems that decrease the effectiveness in developing innovative problem-solvers.[13]

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[11] Walters, Tim, Robert J. Marzano and Brian McNulty. "Balanced Leadership: What 30 years of research tells us about the effect of leadership on student achievement." 2003 < http://www.mcrel.org/PDF/LeadershipOrganizationDevelopment/5031RR_BalancedLeadership.pdf> [8 January 2005], 14.

[12] Clark, Donald. "Learning Domains or Bloom's Taxonomy." 21 May 2000. < http://www.nwlink.com/~donclark/hrd/bloom.html> [28 January 2005].

[13] Clark, Richard E. "Instructional Design and Theories of Learning," Lecture, U.S. Army Engineer School, Fort Leonard Wood, MO: April 2004.

Knowledge - Rule of Primacy

The first problem is based on the rule of primacy. This rule states that when under stress people will respond as first taught, even if the first thing taught was wrong or incomplete. Teaching problem-solving when focused on declarative knowledge can result in delayed understanding of the full cognitive skill. An example is teaching the analysis of terrain during a military operation. A curriculum that is focused on declarative knowledge would teach that terrain is analyzed during Intelligence Preparation of the Battlefield. The impacts of terrain must be considered for both enemy and friendly forces. The analysis is usually written out using a framework of the five military aspects of terrain: obstacles, avenues of approach, key terrain, cover and concealment, and observation and fields of fire. Students might then be given a map and asked to write out their analysis. Their response might then be graded on whether they had five sections, one for each military aspect of terrain, and if an impact was identified for both friendly and enemy forces. This would become the common answer for terrain analysis. Yet this is an incomplete answer and fails to address the essential linkages between understanding the impacts of terrain and the development of feasible courses of action. This "so what" aspect of the answer is lacking and because of the rule of primacy, when under stress this becomes the likely level of analysis. Additionally, getting the student beyond the surface analysis becomes more difficult because it was learned in the wrong context without the appropriate links to the other portions of the process.

Knowledge - Discovery Learning Limitations

The second problem builds off the first. Discovery learning, which includes self-study, when not guided with corrective feedback, can cause students to learn the wrong thing. Continuing with the terrain analysis example, students had to identify impacts of terrain. A

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student might make the assumption that the green areas on a topographic map indicate vegetated areas that are impassable to vehicular traffic. From this assumption, the student may determine that the enemy only has two avenues of approach. If the instructor only examines the format and rote execution of the process without providing corrective feedback on the logic or accuracy of the answers, the student potentially learns the wrong thing. Again, due to the rule of primacy, the future process output may be incorrect, despite academic success. Discovery learning may be teaching the students the wrong things if it is not focused with corrective feedback.

Knowledge - Importance of Examples

The third problem ties all three together. Discovery learning is usually supported by referring the students to examples. Good examples can help students; bad examples can actually hinder the learning process. In the above example, students analyzed the terrain to support the planning of a military operation. If given an example that clearly shows the linkage between the impacts of terrain and the enemy and friendly courses of action then the student's ability to perform the analysis will improve. If the same student is given an example that simply shows the format and does not support the rest of the planning process then the student's ability to perform this skill will not improve. Additionally, this example may reinforce an incorrect process and hinder his ability to learn the correct method.

Shortfalls - Counterargument

Some would argue that the operational-level problem solver is trained at the services' Command and General Staff Colleges (CGSC) (or the junior course of the Naval War College). They would argue that a majority of the deficiencies highlighted above are corrected. This is not correct. First, the curriculums are still based on the concept of linking.

Military decision making is taught by teaching the parts and then expecting the students to synthesize the whole. Second, expertise in a cognitive skill requires almost 10-years of practice. Field grade officers attending CGSC average 12-years of service. This means that proficiency comes at the end of a career, not when it is needed. Third, declarative knowledge still forms the basis of developing the curriculums when it comes to problem-solving. At the Naval War College, the Joint Operations Planning and Execution System is taught so that the students will *know* the process. The graded practical exercise validating this knowledge is for all intents and purposes a fill-in-the-blank operations order. The same types of events can be found in all four services. Although the curriculums and level of education is higher at the CGSC level schools they do not adequately provide innovative problem-solvers to the operational force.

The shortfalls of our current officer education system make it inadequate for preparing officers to function as innovative problem-solvers at the operational level. The misunderstanding of how learning occurs, the difficulty in training, preparing and resourcing instructors and the focus on declarative knowledge all contribute to the inadequacies. When combined, the three key limitations of officer professional development hinder the acquisition of the complex cognitive skills associated with innovative problem-solving.

Critical Thinking as the focus for Professional Development

The contemporary operating environment displays a fractal complexity and this places a greater burden on younger leaders and staff officers to solve problems that have potential strategic and operational impacts. The complexity and novelty of these problems can not be adequately handled by the use of a rote decision-making process. Developing the best solution in a situation that has no one correct answer requires officers capable of innovative

problem solving. The difficulty that faces our military today is the practical problem of how

we develop this capability in our officers. Critical Thinking (CT) as a skill offers the

framework for training innovative problem solving.

Critical Thinking training can provide better military problem solvers. However,

understanding why Critical Thinking offers a useable framework for military education

requires an understanding of what CT is. It is also important to understand when it is

required. Finally, it is also important to examine whether Critical Thinking is suitable for the

military.

Focus - Concept of Critical Thinking

Critical Thinking does not have a single agreed upon definition, but as a general

concept it is understood to be the skill of determining the most correct answer or belief. [14]

This skill uses cognitive skills (thinking) and skills in evaluating your thought processes to

reduce errors in your thinking (meta-cognitive skills) to increase the probability of generating

the most correct answer.[15] The meta-cognitive part of Critical Thinking is what differentiates

it from traditional problem-solving or decision-making processes. In practice, Critical

Thinking allows the generation of a solution and then self-corrects the solution by critically

questioning and evaluating the gaps or conflicts in the solution and the thought processes that

generated the solution.[16] The self-correcting aspect is what enables innovation. By

identifying errors, gaps or bias in the development of a solution, the critical thinker is able to

harness his imagination to develop novel solutions.

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[14] Gwilliam, Jeffery L. Critical Thinking: a strategic competency. Carlisle Barracks, PA, Army War College, 2002. (LTC Gwilliam includes a good collection of many of the definitions of Critical Thinking.)
[15] Riedel, Sharon L. ed., "Training Critical Thinking Skills for Battle Command," 23.
[16] Ibid, 52-84.

Focus - Is it Applicable?

Dr. Marvin Cohen was asked by the Army Research Institute to examine whether "critical thinking" is applicable to the U.S. Army's needs.[17] As part of this research he identified three conditions that required Critical Thinking. These conditions or groups were problem difficulty, decentralized social and organizational structure, and high stakes.

> Do conditions for the use of critical thinking apply in the Army? The answer certainly appears to be yes. There is a growing interest in critical thinking among Army instructors and researchers, which seems warranted by the complexity and changing character of military planning and operations; decentralization of the organizational structure (e.g., the demands of leadership, coordination, and initiative within every echelon); and high stakes personally, organizationally, and for the nation as a whole. In addition, the direction of change in the Army promises to make critical thinking even more important. These changes include the growing complexity of military tasks, the rapid evolution of technology and missions, the flood of information unleashed by the new technology, increasing diversity of military organizations, and the growing interest in tactics that rely on initiative by local commanders.[18]

Doctor Cohen's answer can easily apply to the other services. Given the complexities of the modern joint battlefield there is clearly a valid requirement for critical thinkers in the military.

Focus - Military Requirements

Despite the validity of requirement, the question remains as to whether Critical Thinking Training is able to meet the military's requirements. To answer this question I decided to research what Critical Thinking training and research was occurring in the military. A significant number of organizations and individuals in the military are studying, developing and using elements of Critical Thinking. As examples, the Air War College has one of the best collections of internet links to studies and research about Critical Thinking.

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[17] Ibid, 50.
[18] Ibid, 50.

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The Army, Naval, and Air War Colleges teach courses on Critical Thinking. The

curriculums of the CGSC level courses in the services include elements that require higher

level cognitive skills associated with Critical Thinking (i.e. argumentative essays that require

consideration and refutation of counter-arguments). The Army Research Institute and the

Office of Naval Research have respectively funded studies in critical thinking and cognitive

skill acquisition.[19] The amount of work being conducted on critical thinking appears to

partially answer the question. There is a belief that Critical Thinking may meet the military's

needs if the theoretical concepts can be translated to practical applications.

Practical Applications of Critical Thinking for Officer Development

The practical application of imbedding Critical Thinking into officer development

requires a fundamental change in what we evaluate, significant changes in course design and

a standardized framework for conducting the evaluation. The most important element of

developing critical thinkers is to evaluate and help them self-evaluate their reasoning. Next,

instructors must be trained to support the new approach. This change of approach requires

some changes in course materials and instructional design, in so far as the products the

officers must produce changes. Then the framework for evaluating the cognitive skills of

critical thinking must be standardized and used throughout the professional development

system. Finally, this approach must start very early in an officer's career so that ample time

is provided to generate the necessary proficiency when they are required to function at the

operational level.

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[19] Anderson, John R., "Acquisition of Cognitive Skill,"369; Riedel, Sharon L. ed., "Training Critical Thinking Skills for Battle Command," i.

Applications - What do we need to evaluate?

We must no longer solely evaluate the answer given, but also evaluate the reasons it was the answer given. Typically an officer is evaluated on the answer he provides. Is it good? Is it bad? What is right and what is wrong with it? This seldom helps the officer get better at developing solutions; it simply helps them get better at solving that specific solution. The problem is not with the solution but with how the solution was developed. Evaluating an officer's reasoning for his solution and correcting errors in that reasoning will increase the quality of future solutions. In this aspect it resembles math instruction. The answer is only a small portion of what is evaluated; the majority is the process used to get the answer. By correcting errors in the process, we increase the probability of getting correct answers and the individual's ability to use the processes to solve new and unique problems increase.

Applications - Training the Instructors

The hardest aspect of incorporating critical thinking into current courses is the training of the instructors.[20] Before curriculums can be modified to emphasize reasoning over knowledge, the instructors must understand Critical Thinking and how it is to be integrated into their course. This can be done by setting up a train the trainer program. This should include the academic aspects of critical thinking, reasons for incorporating changes and very specific examples of how it will be done in the course. The program must also carefully address the three primary arguments instructors will raise against the changes. The first is an increased work load, the second is difficulty in evaluating and providing feedback, and the third is that the students will not be capable of performing at the higher level.[21] The work

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[20] Paul, Richard. "Why Students and Teachers Don't Reason Well." 1993. < http://www.criticalthinking.org/resources/articles/why-students-teachers-dont-reason.shtml> [5 February 2005].

[21] This is from my personal experiences when integrating Critical Thinking into the U.S. Army's Engineer Command and Staff course.

load can be maintained by shifting the burden of instructing classes that are strictly knowledge focused to the students as self-study. The evaluation and feedback mechanism will be designed around the Universal Intellectual Standards and will use focused rubrics. Finally, students will perform to the level expected of them. If the course is designed correctly and the instructors provide the correct feedback, the average performance of the students will rise. When the instructors understand and accept the change in focus the remainder of the integration process is simplified.

Applications - Instructional Design

Instructional design must set the conditions for Critical Thinking to occur. Critical Thinking training can not be handled as a purely academic discussion. Though an academic understanding of Critical Thinking may be of value later in a career, initial military education can incorporate it without straying from the critical task lists used to develop course curriculums. Critical Thinking skills can be incorporated in to current courses by making the standard declarative knowledge a pre-condition for the instruction, by teaching and using argument/concept mapping to expose student reasoning, and by integrating historical analysis.

Design - Declarative Knowledge as a Pre-condition

The amount of time available for instruction is limited, so it is important to use this time to develop better thinkers, rather then better memorizers.[22] The most effective way to do this is by making the essential declarative knowledge a pre-condition for the instruction rather then the focus of instruction. By this, I mean make the rote knowledge portion be a pre-study. This way the actual instructional time can be used for application training. As a

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[22] The U.S. Army is decreasing the amount of time officers spend in institutional training.

change to course design, this may initially entail changing lectures to self-paced study during the course time. The reduction in time spent on knowledge based classes will increase the available time of instructors to focus on cognitive skills of problem solving.

Design - Argument/Concept Mapping

Course design must include a method to allow students to show their reasoning when developing solutions. Argument/Concept mapping is a graphical method of showing the reasoning behind an argument or solution (See Appendix 2). Significant evidence shows that argument mapping enhances a student's ability to critical think.[23] Incorporating argument/concept mapping into our instruction allows the students and the instructors to evaluate and correct faulty reasoning. This critical review of the reasoning behind answers is the key element of imbedding critical thinking in officer development.

Design - Historical Analysis

Expertise is defined as knowledge combined with critical thinking.[24] Dr. Cohen continues his definition by explaining that expertise in war fighting is linked to the knowledge of war fighting. That is the "…experience and study of the patterns, rules, and principles that apply in warfare."[25] This war fighting knowledge has three components: doctrine, personal experiences and historical examples. The doctrinal aspect of education is already fully integrated. The personal experiences are integrated in classes that use small group or seminar instruction techniques. Historical studies are, however, poorly integrated in

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[23] Tardy, Charles R. "Argument Maps Improve Critical Thinking." June 2004. <http://www.csse.monash.edu.au/~ctwardy/Papers/reasonpaper.pdf> [6 January 2005].

[24] Cohen, Marvin. "Battlefield Critical Thinking Skills." Critical Thinking Training for the Battlefield. 1999. < http://www.cog-tech.com/projects/CriticalThinkingTraining.htm> [5 February 2005].

[25] Ibid

courses prior to CGSC level. Historical study is generally a reading list. This is woefully

unacceptable. The analysis of historical case studies should be integrated with the doctrine

and personal experience. This analysis should use argument mapping to examine the

reasoning that occurred in the historical case study. By having the students evaluate the

reasoning of historical decisions; their ability to self-evaluate their own decisions will

increase.

Applications - Universal Intellectual Standards

Developing officers that can critically examine their thinking and their answers requires

a common set of evaluation criteria focused on their cognitive skills. The Universal

Intellectual Standards offers a set of criteria that enables this.[26]   These standards include

clarity, accuracy, precision, relevance, depth, breadth and logic (See Appendix 3). The

typical standard of correct and incorrect is inadequate for evaluating reasoning and solutions

without a single correct answer. Using the Universal Intellectual Standards, when combined

with argument mapping, allows for detailed feedback that supports self-evaluation by the

students. It also allows the instructor to identify specific weaknesses of students and tailor

future instruction.

Embedding Critical Thinking into officer education requires some cultural changes in

how we teach. By shifting the focus of evaluation to student reasoning, making the rote

knowledge part of self-study, teaching and integrating argument/concept mapping and

evaluating students using the Universal Intellectual Standards, officer education can begin to

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[26] Elder, Linda and Richard Paul. "Universal Intellectual Standards." June 1996. <
http://www.criticalthinking.org/resources/articles/universal-intellectual-standards.shtml> [5 February 2005].

deliberately develop the innovative problem-solvers that required at the operational level. Making this happen also requires that our instructors and course developers understand and accept these changes.

Example of Embedding Critical Thinking.

As an example, to clarify the above recommendations, I will show how we could embed critical thinking into a block of instruction on terrain analysis. The purpose of this instruction is to develop officers that can analyze terrain to provide recommendations on courses of action. This skill is typically taught by presenting the declarative knowledge and then having the students prepare a written analysis. Adjusting this to emphasize the cognitive skill of analysis requires two steps. The first is to shift the declarative portion to a pre-study requirement and the second step is to use a series of practical exercises that force the students to identify and evaluate the reasoning involved in terrain analysis and carefully link it to the overall planning process.

The first step is to identify the essential declarative knowledge the student needs to understand what to do. In this example the students are assigned readings from doctrine that describes terrain analysis and how it relates to intelligence preparation of the battlefield and the overall planning process. Also assigned is an example of a well written historical terrain analysis; "Terrain Factors in the Russian Campaign" Center of Military History Publication 104-5. This knowledge prepares the students for the application instruction.

The second step is a series of practical exercises that incorporate argument mapping, self and peer evaluations using the Universal Intellectual Standards and additional historical case studies.

Exercise #1 – Students read a historical case study of the German Operation Barborossa (this is deliberately linked to the example provided for self-study). They then produce a concept map that outlines the reasoning for the course of action developed and used. Based on the example terrain analysis, the students evaluate the reasoning using the Universal Intellectual Standards (UISs) and discuss in seminar format.

Exercise #2 - Students read a prepared terrain analysis, and given three courses of action, recommend one based on the terrain analysis. (Provide an argument map) Students present recommendations and evaluate each others argument map using the UISs. Instructor evaluates and provides written feedback.

Exercise #3 – Students are provided a written terrain analysis and they evaluate the impacts identified using the UISs. (Instructor evaluates their evaluation.)

Exercise #4 – Students are provided a partially complete Terrain Analysis and the students complete. Switch with another student and have them evaluate the impacts identified using the UISs.

Exercise #5 – Give students three courses of action and topographic products. Have student prepare a terrain analysis and recommend a course of action based on terrain. Provide written analysis and an argument map for their recommendation. Instructor evaluates.

Embedding critical thinking skills into the current curriculum increases the value of the training as well as conditions the students to critical evaluate their reasoning. This change is not conceptually difficult and does not involve changing the end state of current instruction. What it does allow is the development of critical thinking skills that can transfer to new problems and enable innovative problem solving.

Conclusion

      History is filled with examples of military leaders that displayed the capability of innovative problem solving. Historical tradition tells us that these military geniuses were born not made. I suggest that the military "genius" is the result of intellectual training. However, this training has been for the most part a matter of Darwinism. Because of the lack of understanding of how to train the core skills of innovative problem-solving, institutional training and professional development has not prepared officers to operate in the joint contemporary operating environment. This inadequacy can be addressed by using Critical Thinking as the focus of officer development and by using the Universal Intellectual Standards as the basis of feedback. Finally, because of the time required to develop expertise in a cognitive skill, this integration must begin upon commissioning and occur during all officer training if we are to deliberately develop officers capable of solving the operational problems of the future.

Appendix 1 (Bloom's Taxonomy)[27]
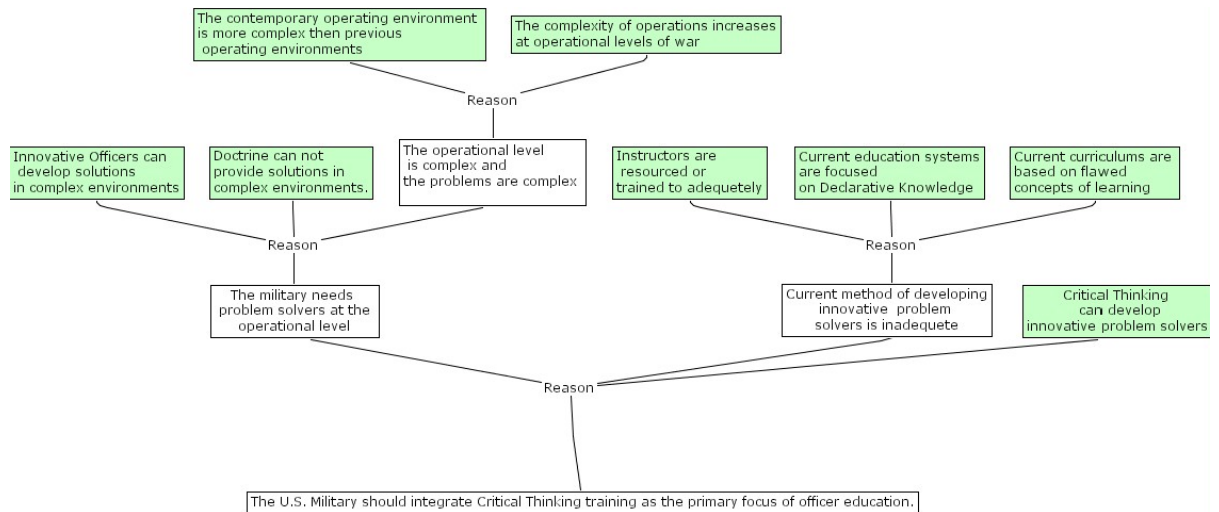
Knowledge: Recall of data.	Examples: Recite a policy. Quote prices from memory to a customer. Knows the safety rules. Key Words: defines, describes, identifies, knows, labels, lists, matches, names, outlines, recalls, recognizes, reproduces, selects, states.
Comprehension: Understand the meaning, translation, interpolation, and interpretation of instructions and problems. State a problem in one's own words.	Examples: Rewrites the principles of test writing. Explain in one's own words the steps for performing a complex task. Translates an equation into a computer spreadsheet. Key words: comprehends, converts, defends, distinguishes, estimates, explains, extends, generalizes, gives examples, infers, interprets, paraphrases, predicts, rewrites, summarizes, translates.
Application: Use a concept in a new situation or unprompted use of an abstraction. Applies what was learned in the classroom into novel situations in the workplace.	Examples: Use a manual to calculate an employee's vacation time. Apply laws of statistics to evaluate the reliability of a written test. Key Words: applies, changes, computes, constructs, demonstrates, discovers, manipulates, modifies, operates, predicts, prepares, produces, relates, shows, solves, uses.
Analysis: Separates material or concepts into component parts so that its organizational structure may be understood. Distinguishes between facts and inferences.	Examples: Troubleshoot a piece of equipment by using logical deduction. Recognize logical fallacies in reasoning. Gathers information from a department and selects the required tasks for training. Keywords: analyzes, breaks down, compares, contrasts, diagrams, deconstructs, differentiates, discriminates, distinguishes, identifies, illustrates, infers, outlines, relates, selects, separates.
Synthesis: Builds a structure or pattern from diverse elements. Put parts together to form a whole, with emphasis on creating a new meaning or structure.	Examples: Write a company operations or process manual. Design a machine to perform a specific task. Integrates training from several sources to solve a problem. Revises and process to improve the outcome. Keywords: categorizes, combines, compiles, composes, creates, devises, designs, explains, generates, modifies, organizes, plans, rearranges, reconstructs, relates, reorganizes, revises, rewrites, summarizes, tells, writes.
Evaluation: Make judgments about the value of ideas or materials.	Examples: Select the most effective solution. Hire the most qualified candidate. Explain and justify a new budget. Keywords: appraises, compares, concludes, contrasts, criticizes, critiques, defends, describes, discriminates, evaluates, explains, interprets, justifies, relates, summarizes, supports.

[27] Clark, Donald, "Learning Domains or Bloom's Taxonomy," 21 May 2000, < http://www.nwlink.com/~donclark/hrd/bloom.html> [28 January 2005].

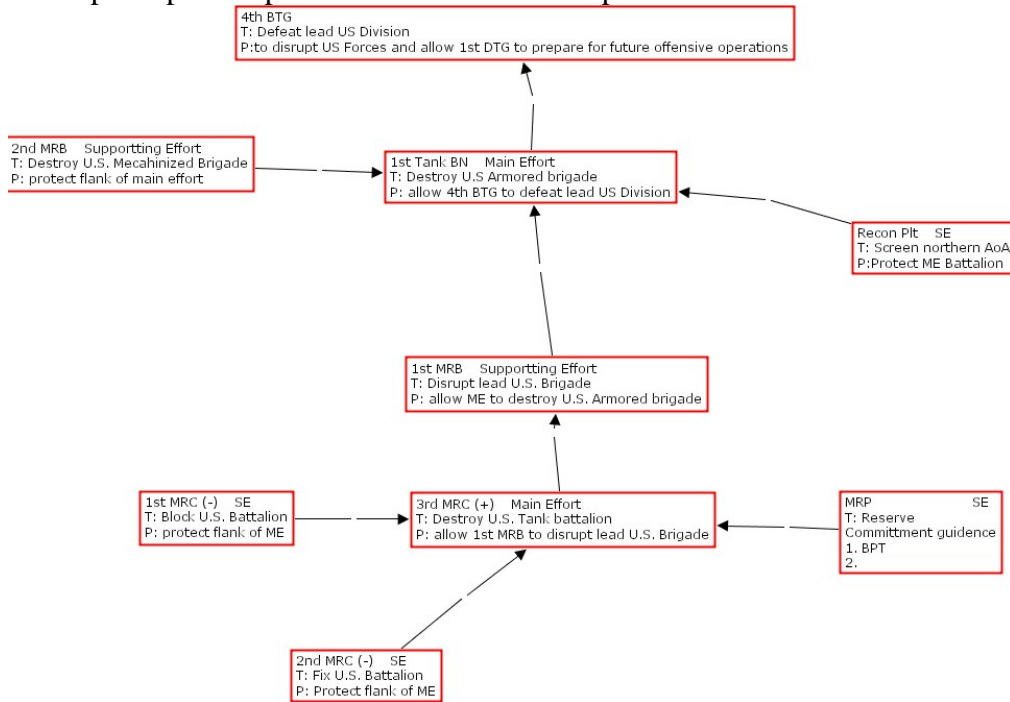# Appendix 2 (Argument/Concept Mapping)

Concept mapping and Argument mapping provide a graphical method of representing reasoning. By forcing individuals to map out their arguments the ability to evaluate the flaws or gaps in their reasoning becomes easier. Feedback on their argument map uses the Universal Intellectual Standards.

Argument Map – Critical Thinking and Innovative Problem-solvers

Concept Map Example – Nested Task and Purpose of a Threat Unit

4th BTG
T: Defeat lead US Division
P:to disrupt US Forces and allow 1st DTG to prepare for future offensive operations

2nd MRB   Supportting Effort
T: Destroy U.S. Mecahinized Brigade
P: protect flank of main effort

1st Tank BN   Main Effort
T: Destroy U.S Armored brigade
P: allow 4th BTG to defeat lead US Division

Recon Plt   SE
T: Screen northern AoA
P:Protect ME Battalion

1st MRB   Supportting Effort
T: Disrupt lead U.S. Brigade
P: allow ME to destroy U.S. Armored brigade

1st MRC (-)   SE
T: Block U.S. Battalion
P: protect flank of ME

3rd MRC (+)   Main Effort
T: Destroy U.S. Tank battalion
P: allow 1st MRB to disrupt lead U.S. Brigade

MRP   SE
T: Reserve
Committment guidence
1. BPT
2.

2nd MRC (-)   SE
T: Fix U.S. Battalion
P: Protect flank of ME

Appendix 3 (Universal Intellectual Standards)[28]

1. **CLARITY:** Could you elaborate further on that point? Could you express that point in another way? Could you give me an illustration? Could you give me an example?
   Clarity is the gateway standard. If a statement is unclear, we cannot determine whether it is accurate or relevant. In fact, we cannot tell anything about it because we don't yet know what it is saying. For example, the question, "What can be done about the education system in America?" is unclear. In order to address the question adequately, we would need to have a clearer understanding of what the person asking the question is considering the "problem" to be. A clearer question might be "What can educators do to ensure that students learn the skills and abilities which help them function successfully on the job and in their daily decision-making?"

2. **ACCURACY:** Is that really true? How could we check that? How could we find out if that is true?
   A statement can be clear but not accurate, as in "Most dogs are over 300 pounds in weight."

3. **PRECISION:** Could you give more details? Could you be more specific?
   A statement can be both clear and accurate, but not precise, as in "Jack is overweight." (We don't know how overweight Jack is, one pound or 500 pounds.)

4. **RELEVANCE:** How is that connected to the question? How does that bear on the issue?
   A statement can be clear, accurate, and precise, but not relevant to the question at issue. For example, students often think that the amount of effort they put into a course should be used in raising their grade in a course. Often, however, the "effort" does not measure the quality of student learning, and *when this is so*, effort is irrelevant to their appropriate grade.

5. **DEPTH:** How does your answer address the complexities in the question? How are you taking into account the problems in the question? Is that dealing with the most significant factors?
   A statement can be clear, accurate, precise, and relevant, but superficial (that is, lack depth). For example, the statement "Just say No" which is often used to discourage children and teens fro using drugs, is clear, accurate, precise, and relevant. Nevertheless, it lacks depth because it treats an extremely complex issue, the pervasive problem of drug use among young people, superficially. It fails to deal with the complexities of the issue.

6. **BREADTH:** Do we need to consider another point of view? Is there another way to look at this question? What would this look like from a conservative standpoint? What would this look like from the point of view of...?

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[28] Elder, Linda and Richard Paul, "Universal Intellectual Standards," June 1996. < http://www.criticalthinking.org/resources/articles/universal-intellectual-standards.shtml> [5 February 2005].

A line of reasoning may be clear accurate, precise, relevant, and deep, but lack breadth (as in an argument from either the conservative or liberal standpoint which gets deeply into an issue, but only recognizes the insights of one side of the question.)

7. **LOGIC:** Does this really make sense? Does that follow from what you said? How does that follow? But before you implied this and now you are saying that; how can both be true?

When we think, we bring a variety of thoughts together into some order. When the combination of thoughts are mutually supporting and make sense in combination, the thinking is "logical." When the combination is not mutually supporting, is contradictory in some sense, or does not "make sense," the combination is not logical.

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