

Play a Winning Game: An Implementation of Critical Thinking Training

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World events of the last two decades demand a reorientation of military missions. Military deployment has shifted away from preparing for major large-scale conflicts toward coalitional, peacekeeping, and other forms of newer types of operations. Thus, military expertise is challenged by having to work “out of context.” Military commanders need the tactical knowledge and skills for successfully preparing, executing, and managing operations in new forms of unpredictable, unstable, and complex conditions (Lussier, 2003).

The Royal Netherlands Army, in particular, has ascertained that their current training programs are unable to bring personnel to the required levels of tactical competence for new contexts of operations. In addition, tactical knowledge is “seeping out” of the organization to such an extent that operational readiness is at risk (Benoist & Soldaat, 2004). For personnel who continue service in the military, there may also be an issue of “shallowness” of the level of tactical knowledge and expertise, relative to the new contexts for military operations. Commanders often have basic knowledge of tactical procedures, but current training programs, designed for an older context and era, provide insufficient opportunities for learning so that personnel can recognize the situational subtleties that make the application of a new tactical procedure appropriate (or inappropriate). This problem has been denoted as “lack of reference,” and is a prime example of the challenges created by “expertise out of context.”

To bring trainees up to the level of tactical experts, they need:

- Intensive, deliberate, and reflective practice (Ericsson, Krampe, & Tesch-Rmer, 1993).
- Active engagement in situation assessment and decision making in representative and relevant cases (Klein, 1998).
- Practice at studying cases from different perspectives, acknowledging the relevance of the right cues and their interdependencies (Cohen, Freeman, & Thompson, 1998).

Clearly, new concepts for training tactics are needed.

Studies of tactical decision making have shown that experts have large collections of schemas, enabling them to recognize a large number of situations as familiar. When faced with a complex and unfamiliar tactical problem, experts collect and critically evaluate the available evidence, seek consistency, and test assumptions underlying an assessment. The nature of this process can be described as experience-based iterative problem solving in which correcting for one problem sometimes leads to identification of another problem (Cohen et al., 1998). Expert decision makers thus try to integrate the results into a comprehensive, plausible, and consistent story that can explain the actual problem situation. Novices, on the other hand, often consider aspects of the situation literally (vs. conceptually), and take cues, factors, or features separately and treat them as being independent.

In order to help trainees to become tactical experts, newer concepts for training are based on the known characteristics of experts. A major change in the view of how decision making should be trained has been brought about by Naturalistic Decision Making (NDM) research (e.g., Klein, 1998; Klein, McCloskey, Pliske, & Schmitt, 1997). Klein and colleagues have shown that experts rely on their accumulated experience by recognizing pattern similarity between actual and stored decision-making situations. This has been formalized in the recognition-primed decision (RPD) model (Klein, 1993). There is evidence that trainees in the military regard the core idea of RPD to be naturally applicable to their tactical planning and results of RPD training suggest several benefits over traditional models of decision making that have been in use by the military. Ross and colleagues used the RPD model to develop the recognition planning model (RPM; Ross, Klein, Thunholm, Schmitt, & Baxter, 2004). Instead of generating and comparing COAs (courses of action) as the MDMP (military decision-making process) requires, RPM stimulates sizing up situations and facilitating replanning as part of the cycle of continuously improving and adjusting a COA. The researchers assessed feasibility and acceptability of this method in a 2-week field study at the Fort Leavenworth Battle Command Battle Laboratory (Ross et al., 2004). An ad hoc Objective Force Unit of Action (UA) staff received 2 days of training in the RPM, using electronic tactical decision games to practice this type of decision making. The next phase of the

experiment included 5 days of exercising the RPM by planning and executing different missions. The researchers used observations, questionnaires, and in-depth interviews of key personnel to collect data during the experiment. Findings showed that face validity for the RPM was high, and that participants had little trouble using the RPM.

Trainees not only need to know how and when to make use of stored experiences, they also need to know how to handle novel and ambiguous situations. This includes, for example, how to deal with conflicting and unreliable data, when to abandon an assessment in favor of an alternative one, when to stop thinking and start acting. It is these skills that are addressed in a new training concept, referred to as *critical-thinking training* (Cohen et al., 1998).

Critical thinking can formally be defined as asking and answering questions about alternative possibilities in order to better achieve some objective (Cohen, Adelman, Bresnick, Freeman, & Salas, 2003). The critical-thinking strategy involves a problem-solving approach to new and unfamiliar situations. It is a dynamic and iterative strategy, consisting of a set of methods to build, test, and critique situation assessments. These methods are to some extent generalizable but they can best be taught if grounded in a specific domain and with trainees who already have a basic level of knowledge of that domain. Effective critical-thinking training combines instruction with realistic, scenario-based practice (Cohen et al., 1998). The design of exercise scenarios is very important because these must provide opportunities to practice critical-thinking strategies.

Critical thinking has been successfully used to modify and improve the command planning process (Pascual, Blendell, Molloy, Catchpole, & Henderson, 2001, 2002). In their first study, Pascual et al (2001) compared the command planning processes undertaken by two constructed Joint Task Force Headquarters teams, using a traditional command estimate process and subsequently, a set of alternative planning processes (including RPM). Data were collected through the use of experiment observation proforma, questionnaires, video analysis, and team debriefs. Many participants felt that RPM more closely matched real-world planning processes of experienced planners and better supported the use of intuitive decision-making styles. However, one often-reported weakness of the RPM approach was the absence of formal checklists and a detailed procedural model of the proposed processes. Pascual et al. (2002) subsequently developed and evaluated a refined version of the RPM. This time participants pointed out that the revised RPM should be used by experienced planners because it fits their intuitive and naturalistic problem solving, whereas the traditional estimate process might still be best for inexperienced planners.

Effects of critical-thinking training have been studied in a series of field experiments (e.g. Cohen & Freeman, 1997; Klein et al., 1997) with encour-

aging results. In these studies, trainees received critical-thinking training in scenario-based exercises. Performance was compared to control subjects who did not receive training exercises but participated in activities that are not directly related to tactical command, like filling out psychological test forms, or discussing work-related issues. This allows for the possibility that not critical thinking, but mere participation in scenario-based exercises, accounts for the effects.

In the present chapter, we report on two training studies in which we administered tactical exercises to two groups of officers. One group received critical thinking training whereas the other group received standard training. Performance of both groups was compared during and after training. In the first study, we trained the individual military decision maker using a simple training environment. Commanders take the decisions, but tactical command is typically performed in a team. We therefore carried out a second study investigating the effects of critical-thinking training for teams.

The next section describes how the critical-thinking training was developed. After that the training studies and the results are described. Next an account of our experiences in putting critical thinking into practice is presented.

DEVELOPING THE CRITICAL-THINKING TRAINING

In scenario-based training, trainees prepare, execute, and evaluate exercises that are situations representative of the real world (albeit simplified). It provides trainees with the opportunity to gain experience under controlled and safe conditions (Farmer, Van Rooij, Riemersma, Jorna, & Moraal, 1999). By participating in training scenarios, trainees may gain knowledge about typical problems and their solutions, thereby increasing their experiential knowledge of situation–response relationships. For critical-thinking training, practice involves the following.

Building a Story. A story is a comprehensive assessment of the situation, in which all the existing evidence is incorporated and explained, and assumptions about uncertain aspects of the situation are made explicit. Past, present, and future are addressed in the story. The purpose of story building is to keep trainees from assessing situations solely on the basis of individual or isolated events. Instead, trainees are taught how they can integrate the available information into its context, which may include elements such as the history of events leading to the current situation, the presumed goals and capacities of the enemy, the opportunities of the enemy, and so on.

Testing a Story. Testing a story aims at identifying incomplete and conflicting information. Trainees have to correct these problems by collecting more data, retrieving knowledge from memory, making assumptions about the missing pieces of the story, or by resolving conflicts in the argumentation.

Evaluating a Story. After a story is constructed, it should be evaluated for its plausibility. The decision maker has to take a step back, identify critical assumptions that remain hidden, and play the devil's advocate by attempting to falsify these assumptions, that is, explaining how an assumption can be false and building an alternative story.

Time Management. Critical thinking is not always the appropriate decision strategy. Decision makers have to evaluate the time available and the consequences of their actions. In stressful situations such as those often encountered by military commanders, there may be little time to spare. The decision maker often has to act immediately unless the risk of a delay is acceptable, the cost of an error is high, and the situation is nonroutine or problematic (Cohen et al., 1998). Critical-thinking training focuses on the way trainees apply these criteria.

Intentional Introduction of Ambiguous, Incomplete, and Inconsistent Information. This enables students to produce different explanations for events, recognize critical assumptions of situation assessments, critique and adjust assumptions and explanations, and mentally simulate outcomes of possible decisions.

The following general guidelines were presented to subject-matter experts (SMEs) who were asked to develop scenarios for our critical-thinking training. An abridged example based on these guidelines is added in *italics*:

1. Select a target story representative for the tactical issue associated with one of the learning objectives. *Domain: Ground-to-air defense. Learning objective: Trainee needs to develop a defense plan using personnel, weapon and sensor systems to defend assets (cities, air ports, C2-stations, water supplies, etc). In setting the priorities, trainee must take into account the political situation, the recent military developments, logistic constraints, and so on. Target story is the detachment of a Reaction Force (RF) in a NATO country that is in conflict with a neighbor country. Due to an arrival delay of the commander, the battle captain of the Advanced Party is now in charge of formulating the defense plan.*

2. Use your experience or imagination to develop a basic scenario for this target story.

Basic scenario: Water shortage has caused a conflict between NATO country (Greenland) and its neighbor country (Redland). Greenland has the only natural

water reservoirs in the region at its disposal. However, Greenland has supplied less water than agreed upon to Redland. Redland has announced plans to take over the reservoir area in order to guarantee their water supply at all time. NATO has reacted by deploying an RF. Basic scenario is that, despite their statements, Redland will not capture the water reservoirs by force (insufficient military power, escalation of conflict), nor will they attack the reservoirs by poisoning them (lose-lose situation). Redland is unlikely to attack the city, because of the presence of a large population that has the same religion as the principal religion of Redland. Focus of defence should therefore be the air ports, the C2-structures, and own-troops areas.

3. Modify basic scenario in such a fashion that it allows for alternative interpretations (e.g., by making information incomplete or unreliable, by introducing information that is inconsistent with other information sources, or by making crucial information inaccessible to the decision maker).

Alternative interpretations: during the scenario new information becomes available (some as a result of actions or requests of the trainee, some inserted by the scenario leader), like escalating political statements of Redland; ostentatious statements of military support by Orangeland (a military powerful neighbor of Redland); intelligence information indicating that Redland might have new tactical ballistic missiles capable of precision bombardments (striking certain areas of a city only), and so on.

4. Use the target and alternative stories to imagine what actions you would predict trainees would take to verify or retrieve information. Determine whether the scenario leader should release this information or not (or might again provide incomplete or unreliable information).

STUDY 1

The first study was conducted in the domain of air defence by the Royal Netherlands Air Force, in particular the Tactical Command Station (TCS) of a ground-to-air defense battalion. In an office room, trainee-officers played air-defense scenarios under supervision of a scenario leader, who was a domain expert. The study was conducted in a small, quiet room, using paper and pencil, with the trainee sitting at one desk and the supervisor at another.

The trainee played the role of battle captain; the scenario leader played all other functions (lower and higher control), and introduced the scripted events in the scenario (e.g., battle damage reports, information about enemy movements, identified radar tracks). Prior to each training scenario, the trainee was provided with a short description of the political, military, and civil background situation.

A training posttest design was used, as depicted in Table 8.1.

Sixteen officers took part in the study. All of them were operators of a ground-to-air defense battalion, with different backgrounds and (tactical) ex-

TABLE 8.1
Experimental Design

<i>Condition</i>	<i>Instruction</i>	<i>Training</i>	<i>Test</i>
Critical Thinking group (N = 8)	Instruction and demos in critical thinking	Scenarios 1–6, with support in critical thinking; process and outcome feedback	Scenarios 7–8; without support; no feedback
Control group (N = 8)	No specific instruction	Scenarios 1–6, no support outcome feedback only	Scenarios 7–8; without support; no feedback

perience levels. Age of the participants ranged from 26 to 40 years, with an average of 32. Participants were evaluated according to their tactical education and experience, and matched pairs of trainees were randomly assigned to the conditions. Experience level was equally spread over conditions.

The critical-thinking group received a critical-thinking tutorial, followed by a demonstration in which two scenario leaders (one of them played the role of trainee) showed how critical thinking should be used in the scenarios. Trainees of the control group were instructed to run the scenarios as a normal command post exercise.

Two sets each consisting of three scenarios were used. Two scenario leaders were available. Order of scenario sets and assignment of sets to scenario leaders were counterbalanced. While performing the scenarios, all trainees were asked to think aloud in order to give the scenario leader access to the assumptions and reasoning underlying the assessments and decisions. At predetermined moments, the scenario leader “froze” the scenario for interventions. After each scenario, the scenario leader filled in an evaluation form.

For the critical-thinking group, critical-thinking supporting schemes were available during training. As an example, Figure 8.1 shows a scheme that covers the part of the critical-thinking cycle in which the story is tested.

At scenario freezes, and after completing the scenario, the scenario leader provided support and feedback on the critical-thinking process (e.g., by asking “Which alternative explanations are possible?” or “How can you verify that assumption?”). For the control group, trainees received outcome feedback only (e.g., “That was a good decision,” or “You should have issued that request earlier”).

For the posttraining test, two test scenarios and two scenario leaders were available. Order of scenario and assignment of scenario to scenario leader were counterbalanced. All trainees were asked to think aloud. No support or feedback was given.

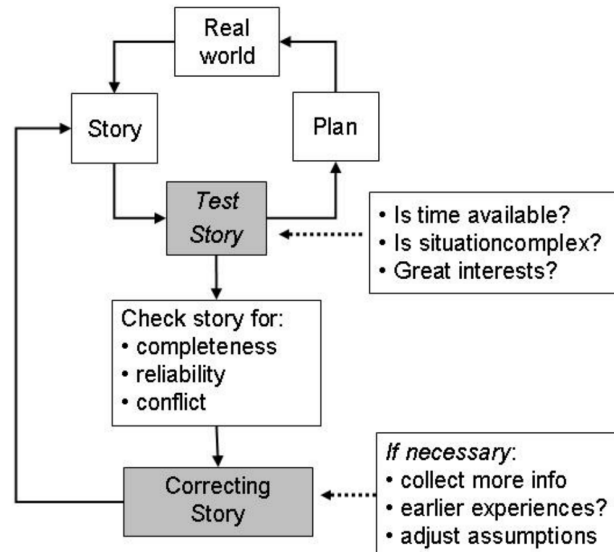


FIG. 8.1. Supporting scheme for story testing.

To investigate the effects of critical-thinking training, both outcome and process measures were used. Outcome measures assess the quality of the end result (what is actually achieved?); process measures refer to the quality of the strategies, steps or procedures used to accomplish the task. The scenario developer specified the required outcome (e.g., order, information request, plan) for each scenario event. Outcome measures were two types: *result* (the assessed quality and timeliness of the plan, communication, actions) and *contingency plans* (assessed degree of anticipation to alternative courses of events in plan and the quality of precautionary measures).

Process measures refer directly to the critical-thinking skills. Process measures were grouped into the following two types: *information processing* (selecting relevant information, story building, identification of incomplete or conflicting information) and *argumentation* (the explanations for missing or conflicting evidence, criticizing assumptions, coming up with alternative explanations).

Trainee performance on all four measures was assessed by the instructor. A 10-point scale was used. A verbal description was used for each scale point, ranging from “very poor” for score 1, to “excellent” for score 10. Prior to the experiment, instructors had used the results of pilot subjects (using samples of the same scenarios) to come to a common understanding of assigning scores.

Results

Figure 8.2 shows median scores on the test scenarios. Kruskal–Wallis tests showed significant differences for *contingency plans* only [$H(1) = 3.91, p < 0.05$]. Scores on the variables *information processing*, *argumentation*, and *result* showed a similar pattern, but the differences between groups were not statistically significant [$H(1) = 1.62, p = 0.21$; $H(1) = 2.08, p = 0.15$; and $H(1) = 1.23, p = 0.27$, respectively].

Discussion

The study offered the battalion commander insight into the tactical competencies of his personnel. This critical-thinking training requires making processes, knowledge, and reasoning more explicit by means of thinking aloud. These features enabled the scenario leaders (squadron leaders in daily life) to see lacunae in tactical competencies of the participating officers that had remained concealed during the exercises that constitute normal training. Furthermore, comparing the average scores on the dependent measures suggested better performance of the critical-thinking group, although the difference reached statistical significance for the contingency measure only.

However, it is necessary to point out that the present study has a number of methodological limitations as well as some limitations in scope. We begin

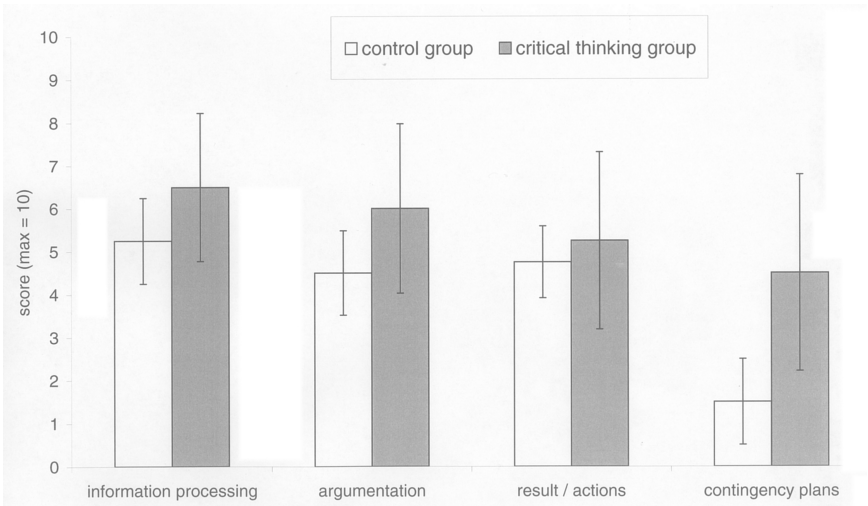


FIG. 8.2. Median scores on the test scenarios.

with addressing three methodological limitations. First, the scoring of trainee performance was conducted by the scenario leaders, who had knowledge of the study's goal and design. Practical limitations forced us to do it this way, but it is not ideal as it may have introduced a confound. More independent assessments are needed. A second problem in making comparisons between groups are the differences in time-on-task. Although both groups received the same number of scenarios and an equivalent number of training sessions, the length of a session was generally slightly longer for the critical-thinking group than for the control group (~ approximately 30–40 minutes for the critical-thinking group; 20–25 minutes for the control group per training session). It is possible that these time-on-task differences account (partly) for the effect. Third, it may be argued that subjects of the critical-thinking group knew that they were getting special training, whereas subjects of the control group did not. In other words, any differences might be the result of a Hawthorne effect. In order to truly rule out the possibility of a Hawthorne effect, a "yoked" control condition is necessary (a group receiving a new form of training that is unrelated both to critical thinking and to current training practice). However, there are arguments making the Hawthorne effect as the sole factor explaining between-subjects differences in this study unlikely. Although the control group was trained conform to everyday training (accent on military tactical issues; little or no guidance or feedback on task processes), the form in which they received training was new to them (one-to-one with an instructor; unusual setting; classroom instead of training in operational task environment; presence of scientists; requiring to talk aloud while carrying out the task, etc.). Thus, subjects of the control group had to deal with another form of training too. "Newness of training" is therefore in our opinion not likely to be the sole explaining factor.

The scope of the present study does not fully cover the potentially wide range of critical-thinking training applications. First, the effect of training was studied in a simple task environment. This proved to be suitable for practicing critical thinking, possibly because the absence of any kind of distracting events (incoming messages, alarms on displays, etc.) kept students focused on the key issues: situation assessment and decision making. Eventually, however, critical-thinking skills need to be applied in the real world. For reasons of transfer, it is necessary to investigate whether critical-thinking skills can be successfully trained and applied in higher fidelity task environments. Another aspect of the present study is that it focuses on the individual commander, whereas tactical command is typically performed in a team. Critical-thinking training for teams may be especially helpful in promoting shared mental models (Stout, Cannon-Bowers, & Salas, 1996), and in preventing "group think" by making team members more critical on implicit or explicit assumptions. In another study, we ad-

addressed the effects of critical-thinking training for teams in a high-fidelity tactical simulator.

STUDY 2

This study investigated the effects of critical thinking applied to the training of command teams operating in more realistic task environments. It was conducted in the domains of “anti air warfare” (AAW) and “anti surface warfare” (ASuW) at the Operational School of the Royal Netherlands Navy. Eight officers and eight petty officers participated in the study. Participants were anti-air-, surface-, or subsurface-warfare instructors at the Tactical Education Department. Age of the officers ranged from 29 to 32 years, with an average of 31. Average on-board experience for this group was 5 years. Age of the petty officers ranged from 29 to 46 years, with an average of 39, and an average on-board experience of 14 years. Participants were grouped according to expertise in either air defense (AAW) or (sub)surface defense (ASW/ASuW) teams. Teams were composed of an officer and a petty officer. Trainees played single-ship/single-threat scenarios in a high-fidelity tactical simulator. This is shown in Figure 8.3. Scenarios were developed by two instructors of the Operational School.

Method

A training posttest design was used. The supervising project officer arranged the eight participating teams according to their tactical education and operational experience, and assigned teams randomly to either the



FIG. 8.3. Research setting.

critical-thinking training group or the control group. The supervising project officer also selected two instructors for the study. They were randomly assigned to train either the critical-thinking teams or the control teams.

Prior to the experiment, instructors who were assigned to train the critical-thinking training teams were extensively briefed on the critical-thinking training method, as well as on how to support trainees in the application of critical-thinking processes.

Instructors assigned to the control team were not informed about the concepts of critical thinking. They were told to support the teams as they would normally during training. Instructors trained one team at a time. The briefing, training, and testing required 4 days per team.

The first day of the study was used for briefing and instruction of the teams. The experimenter and the assigned instructor briefed the critical-thinking team on the principles of critical thinking and showed them how to apply these principles in paper-based demonstration scenarios. The control group instructor briefed his team on the itinerary of the coming days, and discussed a paper-based demonstration scenario with them.

On the second day, teams received two interactive role-playing scenarios in a staff room under supervision of their instructor. On the third day, teams received two scenarios in the tactical simulator. A scenario run took approximately 2 hours. The instructor interventions were the same as in Study 1.

In training the critical-thinking group, the instructor encouraged his team to explicitly execute all critical-thinking components and he provided extensive guidance and feedback during and after the scenarios. For the control group, the instructor supported the control group teams as in normal training, which means they received domain-specific outcome-related feedback, and general encouragement.

On the fourth and final day, teams were tested on two test scenarios in the simulator. Their instructors were not present during the test. The supervising project officer assigned two subject-matter experts for carrying out performance evaluations. These evaluators were not informed about the goals, nature, and design of the study. Assignment of evaluators to teams was counterbalanced (each evaluator rated two critical-thinking teams and two control teams). They assessed performance of trainees individually, as well as that of the team. Evaluators received the scenarios on paper. Markers in the scenario description prompted the evaluators to score trainee and team performance at that particular moment, on specified performance criteria. The same outcome and process measures as in the previous study were used. In addition, performance with respect to *time management* and *team behavior* (communication, supportive behavior, coordination, leadership) was scored. Because the evaluators were used to the NATO 4-point performance-rating scale, it was decided to use this scale in this study.

The verbal descriptions for the four scale points were, respectively: 1 = Unsatisfactory, 2 = Marginal, 3 = Satisfactory, and 4 = Excellent.

Prior to the experiment, the experimenter briefed the evaluators about the scoring procedure and how to use the scale. The results of pilot subjects were used to arrive at a common interpretation of performance measurement.

Results

Data on individual as well as on team performance were collected during training and test. For reasons of brevity, performance data of the teams on the two test scenarios are reported only. Figure 8.4 shows the results on the test scenarios.

Kruskal–Wallis tests showed statistically significant differences for *argumentation* [$H(1) = 7.5, p < .05$], *time management* [$H(1) = 11.4, p < .05$], *contingency plans* [$H(1) = 5.6, p < .05$], and *team skills* [$H(1) = 8.7, p < .05$]. Performance on *information processing* and *actions* did not significantly differ between groups.

DISCUSSION

Critical-thinking training produced positive effects on the *process* of team tactical command (i.e., better argumentation, more effective time management, and better team skills) as well as on the *outcomes* (i.e., more and better contingency plans). Furthermore, we observed that instructions to think

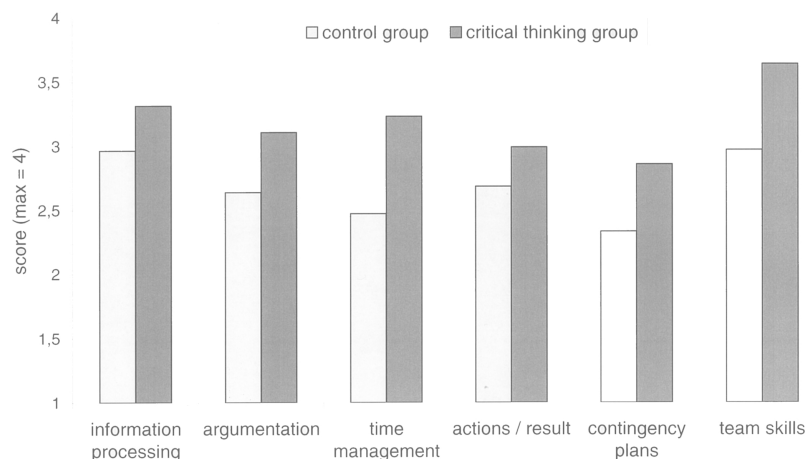


FIG. 8.4. Median results on the test scenarios.

critically supported team members to clarify their assumptions and perspectives on the situation to one another. *For example: Officer: "Considering all information so far, we can be pretty sure that our position is known to the Huang-Fens [enemy ships]. What would then be the reason for the Zulfiqar [enemy ship] to move around in the open and almost act like a sitting duck? Could it be that our position is yet unknown?" Petty officer: "I suppose they do know where we are, and that the Zulfiqar is acting as a distractor."* This type of interaction helps in making assumptions and reasoning explicit and is considered to be important for developing shared mental models and for coordinating team actions (Stout et al., 1996). Apparently, introducing the devil's advocate procedure in training brings about changes in task performance and team behavior that are known to be important for good team performance. This is a significant observation, because in the Navy, the allocation of tasks between the officer and the petty officer is strictly defined, organized hierarchically according to rank. Officers tend not to involve petty officers in tactical issues, and it is certainly highly unusual for petty officers to comment on officers' assessments or decisions. This is clearly a waste of expertise, as petty officers in the Netherlands normally have substantial operational experience. In the present study, the control group teams showed the normal rank-based behavior: petty officers carrying out the tasks assigned to them and officers taking the decisions. Teams in the critical-thinking group on the other hand, showed a different behavior pattern. Officers in this group tended to actively involve petty officers in tactical assessment, for example, by inviting them to play the role of devil's advocate. And the petty officers appeared not to be inhibited to ask officers to clarify their assessments, to make critical comments, and to suggest alternative possibilities.

In contrast with the first study, training was provided in a dynamic and interactive task environment. We observed that in this type of setting, training sometimes became too hectic to fully achieve the objective of this type of training: reflective and critical task performance. This suggests that critical thinking may need to be practiced first in more simple learning environments (e.g. by preparatory paper-and-pencil and role-playing scenarios) before introducing this type of training in simulator exercises. Disruptive effects of distracting events on critical thinking during simulator training may be overcome by introducing time outs during the exercise, offering students the opportunity to perform the required behavior.

Again, it is necessary to point out that due to organizational and logistic constraints, the present study does not fulfill all methodological requirements. First, there is the issue of the training of instructors. It is, of course, necessary that the instructors responsible for delivering the critical thinking-training have a thorough understanding of the concept, rationale, and procedures of critical thinking. We therefore invested quite some effort to

prepare the instructors for their task. Overall the instructors did a fair job. However, understanding a concept, and implementing this concept into training are not entirely the same. "Old" habits of instruction occasionally popped up, as, for example, pointing out the significance of a particular cue instead of letting students discover that for themselves. It is possible that if instructors were trained longer, effects of critical thinking would have been more outspoken. A second issue is the fact that we had only two evaluators available. Both evaluators rated critical thinking teams and control teams, but a team's performance was never rated by both evaluators. Therefore, no interrater reliability data can be computed. Although we invested efforts to make evaluators arrive at conjoint performance evaluations, common interpretation does not necessarily mean that their ratings were reliable or valid.

The results of the present and earlier studies (Cohen & Freeman, 1997; Cohen, Freeman & Thompson, 1997; Cohen et al., 1998; Freeman & Cohen, 1996) warrant further research. First of all, hitherto evidence on the effects of critical thinking is explorative. We need experimentally controlled studies that can unequivocally demonstrate whether critical thinking indeed has beneficial effects, and if so, identify the mechanism that explain such effects. The military, however, does not want to wait for such studies to be conducted. Their hands-on experiences with critical-thinking training and the results obtained so far convinced them that this type of training is a valuable solution to their current and urgent need: adequate tactical training. The urge to make use of critical thinking in real training programs requires answers to questions such as: "How can we integrate critical thinking training into an existing curriculum?", "How should critical thinking be introduced to students?", and "What are students' and teachers' experiences in using this method?". The Royal Netherlands Navy asked us to help them with the implementation of critical thinking in a module of their tactical training program. In the next section, we give an account of our experiences.

PUTTING CRITICAL THINKING TRAINING INTO PRACTICE

Our training studies have shown positive results for critical-thinking training. These training studies were specifically designed to study the effects of our training manipulation. They were mini training courses, conducted under controlled conditions. This is different from any normal training program. In a regular training program, instructors usually have the freedom to treat every student differently, according to the individual

students' needs. In our training experiment, instructors had to treat all students similarly and according to specific experimental protocols. Another difference is the short duration of a training study as compared to a regular training program. A short training intervention may not provide the opportunity for trainees to really master critical-thinking skills. In this section, we report findings and observations of putting critical-thinking training into practice.

Recently, the Operational school of the Royal Netherlands Navy revised its training program for CIC (Command Information Centre) commanders. Two separate curricula, one for the air warfare commander and another for the surface and subsurface commanders, were merged into one. This reorganization offered an opportunity to identify shortcomings of the existing programs, and to bring about improvements in training concepts, methods, and materials for the new training program.

A major criticism on the old training programs was that a wide gap exists between theoretical lessons and practical exercises in the tactical trainers. Theoretical tactical lessons emphasized learning tactical procedures and capacities of sensor and weapon systems. The relevance of the materials and exercises to tactical situation assessment and the implications for decision making often remained implicit. When, later in the training course, trainees were required to bring this knowledge into use during exercises in the tactical simulators, they often lacked the skills to do so.

It was concluded that theoretical lessons should be redesigned in such a fashion that (a) students can develop a satisfactory repertoire of tactical patterns, and (b) there is sufficient opportunity to practice situation assessment and decision-making skills. This should prepare students better for training exercises on the tactical simulator, and for the on-board exercises.

The Approach

To achieve the objectives, we decided to embed critical thinking into Tactical Decision Games (TDGs) exercises. TDGs are a paper-and-pencil training technique that can be used to present tactical problems to trainees. They generally consist of a written description of a tactical problem accompanied by a schematic map. TDGs can be administered individually or to groups. They can be static, requiring trainees to develop a detailed and founded plan, but they can also be dynamic through the use of role players, who introduce events to which trainees must respond. TDG exercises have been used successfully for acquiring contextualized tactical knowledge and understanding (Crichton, Flin, & Rattray, 2000; Klein, 1998).

The Training

The training block “Theory of Anti-Surface Warfare (ASuW)” was selected for the revised training program. A series of four TDG exercises (of different tactical complexity) were developed by an instructor at the Operational School, using the scenario guidelines set out earlier in this chapter. Exercises consisted of a problem and mission description, accompanied by a tactical map. See Table 8.2 for an example TDG, and Figure 8.5 for the accompanying map.

Prior to the training sessions, instructors were instructed extensively on the concept and principles of critical thinking. Observation protocols and performance measures were designed to support instructors in their tasks.

For the trainees, we developed an instruction book on critical thinking within the context of surface warfare, including self-study questions and exercises. In a 2-hour classroom instruction on critical thinking, we familiarized students with TDGs and explained what was to be expected from them in the TDG sessions. TDGs were administered to groups of four students. By turns (so that each of the students got the chance to consider from a distance and gain insight into the group’s performance), one of them was assigned the role of observer using a scoring form to evaluate his group on the following dimensions: information selection and acquisition, argumentation and reasoning, planning and contingency planning.

In addition, an experimenter-observer also evaluated the group’s performance.

TABLE 8.2
A TDG Exercise

Mission: The mission of the TaskGroup (TG) 540.01 is the safe arrival of Her Majesty <i>Rotterdam</i> in the harbor of Bluton.
History and setting: on land, at sea and in the air there have been hostilities and incidents between Amberland and Blueland/NATO, yet there are still merchants and civil aircrafts in the area.
Task: you perform the role of ASuW Commander. Develop your plan and at least one contingency plan.
Tactical issues (for instructors): When student develop (contingency) plans, instructors observe whether the following tactical issues are taken into account: the unknown contacts in the area (where are the Kimons [hostile ships]?); the interception of an enemy Atlantique radar-signal (are we identified/classified?); the possible intentions of the Huang Fens (hostile ships) and the Zulfiquar (enemy ship, equipped with ballistic weapons only); the status of Greenland (on our side?); can we expect a coordinated attack?; is an enemy suicide mission likely? Do students consider the option to split up; is the option to change course and/or speed considered?

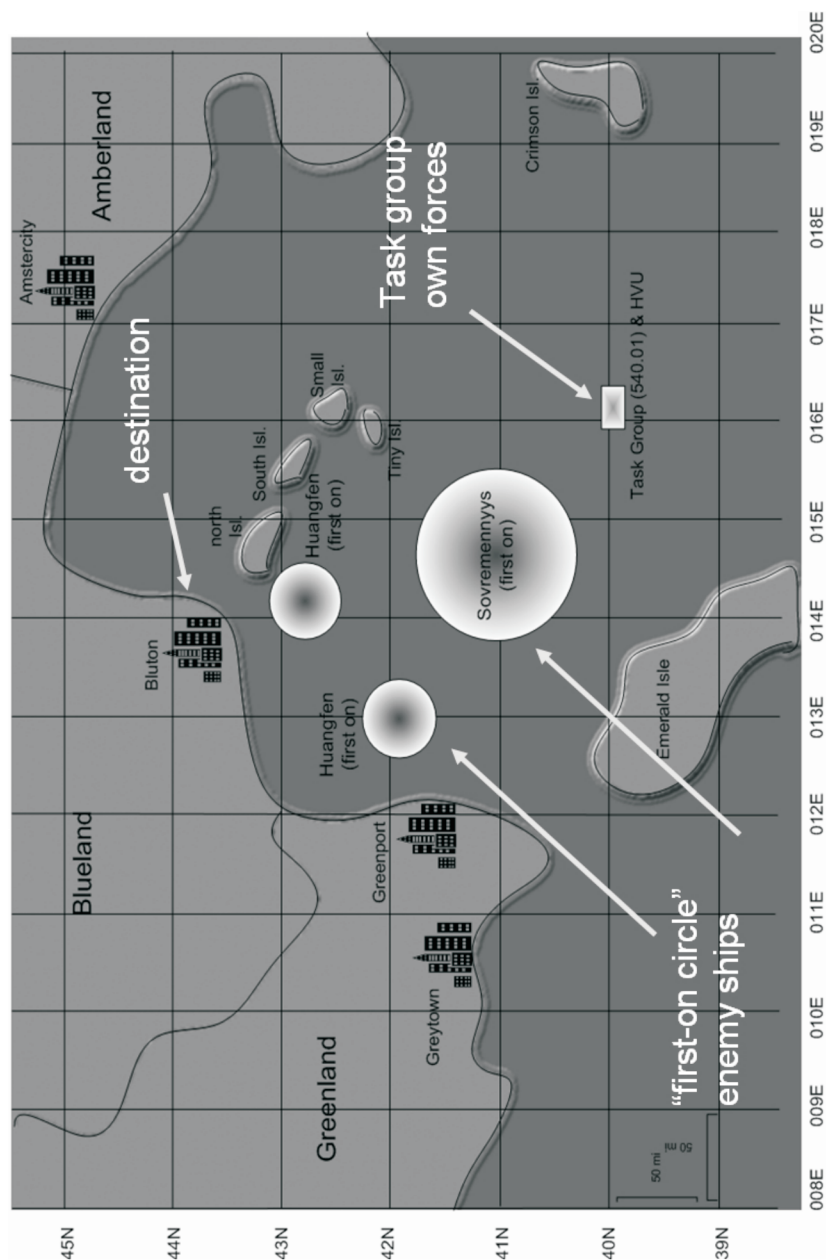


FIG. 8.5. The map that accompanied the scenario laid out in Table 8.2.

Students were asked to clarify their assessments in their discussions, thus giving observers and the instructor access to the assumptions and reasoning underlying their decisions. In order to enhance critical-thinking processes, the instructor requested the students to execute specific critical-thinking tasks, such as “Now try to finalize your initial assessment into a story,” or “Now test your story on conflicting, unreliable or incomplete information,” or “Identify a critical assumption in your story and apply the advocate-of-the-devil technique.” After completion, each group presented their assessments, plans, and contingency plans to the other groups. Tactical key decisions were discussed collectively.

Findings

The majority of students were enthusiastic and motivated to cooperate. They felt that critical thinking helped them to systematically assess a situation, integrate different observations into a coherent story, identify uncertainties and justify assumptions, and come up with (contingency) plans. They appreciated the exercises as a suitable method for consolidating and applying their tactical knowledge, and for practicing their skills in tactical assessment and decision making.

Although the majority of students were distinctly positive, there were also some individuals who failed to appreciate the purpose of the critical-thinking concept. It appeared that some of these students lacked the domain knowledge required to conduct critical thinking as intended. For instance, they were unable to identify a critical assumption in their assessment, or were unable to judge the tactical relevance of ambiguous information. As a result, trainees applied the critical-thinking method in an obligatory fashion, more like a checklist to be completed, rather than as an approach to reflect on the quality of tactical assessments. During after-action reviews they were reluctant to elaborate on alternative assessments, because they considered them to be “too unlikely.”

Instructors were of the opinion that the present concept of training helps trainees to make the necessary shift from passive classroom learning to (inter)active scenario-based training. They felt that the required elaboration on the tactical issues presented in the TDGs helps students to develop tactical schemes, and that critical thinking helps shaping the necessary strategic skills.

The importance of adequate training of instructors can not be overstated, because they have to be able to simultaneously teach, guide, monitor, and assess critical thinking processes. We observed that sometimes instructors fell back on traditional teaching techniques and presented their solutions to students too quickly.

The introduction of the critical-thinking TDG as an alternative concept to training formed a good start toward meeting the objectives of the Operational school, and received support from those involved—students, teachers, and management.

GENERAL DISCUSSION

The international political developments of the last decade incontrovertibly show that military operations are becoming more likely to be carried out under dynamic, complex, and uncertain conditions. However, current training programs have difficulty to bring military commanders up to the required level of tactical competence associated with these types of operations. Commanders do master the basic tactical procedures, but are often unable to acknowledge the relevance of contextual information and take situational subtleties into account when assessing a situation and making decisions. Less experienced commanders are inclined to focus on isolated cues and tend to take them at face value. Furthermore, they are often not explicitly aware of the assumptions they maintain, hence are less critical about them, and are more likely to “jump to conclusions.”

Critical-thinking training has been claimed to be successful. It specifically addresses the two key aspects of expertise: availability of elaborated mental schematas and the ability to build, test and critique situation assessments for novel and ambiguous situations. The benefit of critical thinking is that it enables commanders to sort out what is really important, to address conflicts in available information, and to anticipate and prepare for possible deviations from expected course of events. *For example, the bearing of a track homing on the own ship suggests enemy threat, whereas its low speed indicates a routine patrol. In this case the commander has to recognize this information as conflicting, and further investigate.*

The present study indicates that training commanders in critical thinking is indeed beneficial. The two studies into the effects of critical-thinking training show that it not only improves the *process* of tactical decision making, but also has a positive effect on the outcome. Furthermore, experiences and observations during the implementation of critical thinking in an actual training course of the Netherlands Navy show that all those involved consider the method helpful.

The present studies yielded results and observations that are helpful as a first step for setting up critical thinking training. In order to start critical-thinking exercises, participants must have sufficient domain knowledge and should master the elementary tactical procedures. Apparently, it is best to start critical-thinking training in a simple learning environment, with sufficient time and support to practice all components of the strategy. When

students have sufficiently integrated critical thinking into their tactical planning and command, then exercises in more dynamic and interactive learning environments are in order. Critical thinking is also possible in the training of teams. We observed that students explicated assumptions and argumentations, which is known to be important for developing shared situational awareness among team members (Stout et al., 1996).

The modest successes reported here form only the first steps in the introduction of critical-thinking training in military training programs. In order to expand our knowledge of the effects of critical-thinking training and to survey its opportunities and restrictions, it is important not only to establish the short-term effects of training, but also to investigate how acquired knowledge and skills transfer to novel situations and tasks. In addition, it is of interest to observe how critical-thinking skills are retained during periods of little or no practice. The long-term effects of critical-thinking training are not yet determined. We hope to be able to conduct further evaluations in the near future.

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