Measures for Assessing Command Staff Team Performance in Wargaming Training

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ABSTRACT

Despite the rapid rise in technological aids and decision support tools to assist with command and control activities, wargaming remains an artful and challenging process for command teams to perform. Wargaming, a critical stage in the military decision-making process (MDMP), is a collective activity where command staff representing multiple warfighting functions step through one or more courses of action (COAs) in detail. By considering actions, reactions, and counteractions for each critical event of a COA, the command staff gains an understanding of the decision points, possible coordination problems, feasibility, risks, benefits, likelihood of success, and impact on campaign outcomes. Although there are prescribed MDMP methods and outputs, the art of effective wargaming lies in achieving sufficient team coordination across the command staff to adequately appraise a COA and anticipate synchronization that will be needed for execution, all within the time constraints available for analysis. Consequently, an effective approach to training wargaming ideally involves opportunities for staff to engage in realistic and challenging exercises where they can receive performance assessment and feedback via measures grounded in established constructs for team proficiencies. This paper presents a synthesis of constructs and findings on command team training pertinent to the construction of wargaming exercises. Specifically, a foundation for general principles of teamwork has been established in the literature, and there have also been studies identifying determinants of wargaming effectiveness tied to declarative measures intended for assessment by human instructors or subject matter experts. In order to build on existing research and apply it in an intelligent tutor, these measures and teamwork constructs are synthesized in a model tailored to wargaming performance assessment and feedback for simulation-based team training. Outcomes of this effort will contribute to the development of a prototype for collective training of Army command groups.

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INTRODUCTION

Despite the rapid rise in technological aids and decision support tools to assist with command and control activities, wargaming remains an artful and challenging process for command teams to perform. Wargaming, a critical stage in the military decision-making process (MDMP), is a collective activity where command staff representing multiple warfighting functions step through one or more courses of action (COAs) in detail. By considering actions, reactions, and counteractions for each critical event of a COA, the command staff gains an understanding of the decision points, possible coordination problems, feasibility, risks, benefits, likelihood of success, and impact on campaign outcomes. Although there are prescribed MDMP methods and outputs, the art of effective wargaming lies in achieving sufficient team coordination across the command staff to adequately appraise a COA and anticipate synchronization that will be needed for execution, all within the time constraints available for analysis. Consequently, an effective approach to training wargaming ideally involves opportunities for staff to engage in realistic and challenging exercises where they can receive performance assessment and feedback via measures grounded in established constructs for team proficiencies. This paper presents a synthesis of constructs and findings on command team training pertinent to the construction of wargaming exercises. Specifically, a foundation for general principles of teamwork has been established in the literature, and there have also been studies identifying determinants of wargaming effectiveness tied to declarative measures intended for assessment by human instructors or subject matter experts. In order to build on existing research and apply it in an intelligent tutor, these measures and teamwork constructs are synthesized in a model tailored to wargaming performance assessment and feedback for simulation-based team training. Outcomes of this effort will contribute to the development of a prototype for collective training of Army command groups.

THE MILITARY DECISION-MAKING PROCESS AND WARGAMING

Military leaders in command staff teams must strategize and prepare for a variety of operations under conditions of considerable uncertainty, risk, and time pressure. In the U. S. Army, the MDMP provides a structured methodology to help command staff understand the mission and battle situation, analyze possible courses of action, and generate plans or orders to be executed. The process fosters a thorough, systematic, and rational approach while encouraging critical and creative thinking when planning and solving problems (Department of the Army, 2014). One of the most challenging and vital stages in the MDMP concerns wargaming, which involves iteratively formulating, testing, and refining courses of actions (COAs) to determine the most feasible COA that has the highest likelihood of success.

A command team consists of staff with expertise in different functional areas or battlefield operating systems. When wargaming a single course of action, the command team seeks to discover the strengths and weaknesses of the COA in supporting the mission. Typically, the command team begins with prerequisites such as the mission statement and commander's intent, initial warning orders, essential information needed on friendly and enemy forces, and briefs on the battlefield. They then engage in an information-gathering and processing exercise through which members develop a common understanding of the battlefield and determine the needed resources for executing the COA. When analyzing the COA, the team must also consider its associated "branches," while thinking critically about the assumptions that must be made with that COA and considering potential enemy reactions and subsequent counteractions for each "branch" of the COA. They must ask themselves what their understanding of each incoming piece of information reveals about the assumptions they make and recognize the possible consequences if those assumptions do not hold. The team must realize when they seek confirmatory evidence that could skew their judgment

of event probabilities and how this affects their projected outcomes from the COA (Cohen et al., 1996, 2000). They evaluate the COA in terms of its feasibility, likelihood of success, and risk to friendly forces, among other criteria (Cianciolo & Sanders, 2006). Teams proficient at wargaming are not only aware of the roles of the different staff functions/battlefield operating systems and how their inputs contribute to COA analyses, they can identify the information needs at various stages of the wargame. They are adept at evaluating and appropriately using the information to develop COAs and critically think and test their assumptions at each step. They are creative at imagining and projecting possible outcomes, can anticipate shortfalls and opportunities, as well as discover events or issues that are not easily foreseen (McConnell et al., 2018).

Wargaming has been reported to be difficult to master and train. The U.S. Army's Combat Training Center has consistently cited wargaming among the challenges encountered by training units (Center for Army Lessons Learned, 2018; McConnell et al., 2018). In their cognitive task analysis of wargaming with subject matter experts, Cianciolo and Sanders (2006) cited specific challenges with (i) understanding the implications of friendly and enemy action for the use/availability of personnel, resources, and combat support, (ii) considering the multiple possible enemy reactions to friendly actions, (iii) recognizing decision points and their indicators on the battlefield, and (iv) synchronizing battlefield operating systems in a way that they are leveraged to achieve a decisive result. Given that the operational environment of the military will only continue to increase in complexity, it is imperative that command teams are skilled at wargaming. Improving the quality of wargaming can potentially limit and reduce the number of surprises in mission rehearsals and actual execution (McConnell et al., 2018), increasing the likelihood of achieving the desired mission outcomes with limited loss to life and limb. Cianciolo and Sanders (2006) describe the process in wargaming a single course of action (COA) summarized in Figure 1.

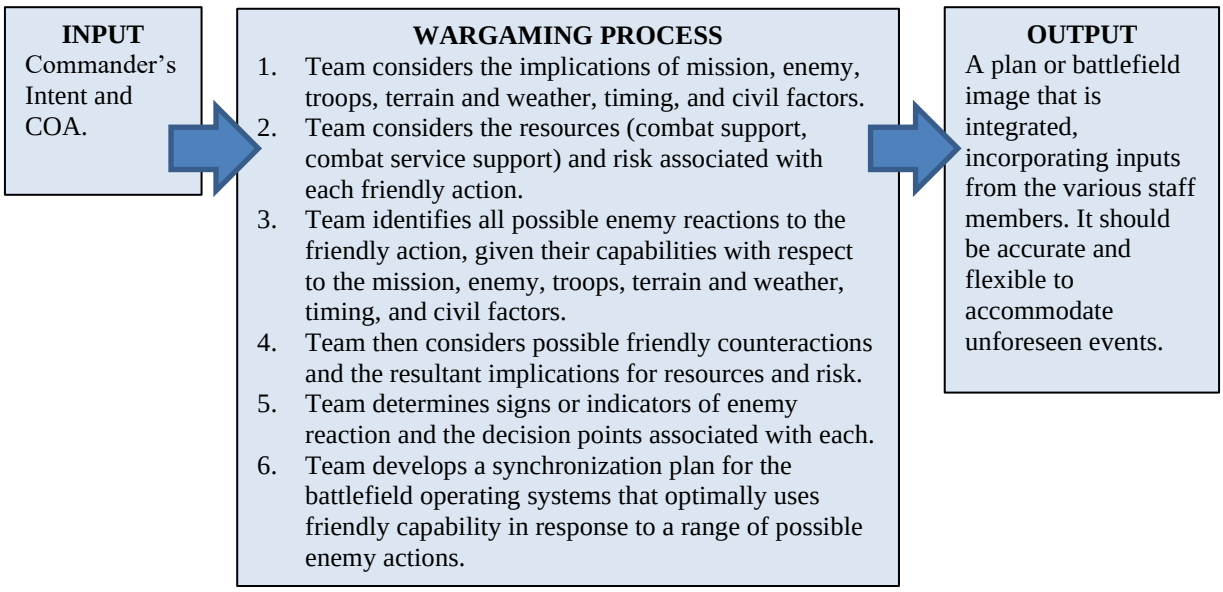

Figure 1. The Wargaming Process for a Single COA as Summarized by Cianciolo and Sanders (2006)

While individuals in the command team should possess the necessary competencies in their respective functional areas, wargaming is a collective task. The level of teamwork among the command team significantly affects the quality of their wargaming. Reports from maneuver Combat Training Centers, Mission Command Training Program Warfighter Exercises, and training allude to the need to train command teams on teamwork competencies. For instance, many COA products did not reflect effective synchronization and coordination among staff as they typically only involved limited staff members. There are also challenges with integrating individual staff members so they understand where and how they fit in the command team and contribute to the common goal of selecting a COA (Center for Army Lessons Learned, n.d.). Although the meeting of learning objectives and attainment of standards for performance remain important goals for trainees and trainers, these outcomes may be more about how well individuals in a particular team made tactical wargaming decisions than about their teamwork per se. It is possible that a team can perform well together, but the same level of performance may not be observed when the individual members of the team leave to be a part of other teams. This may be true if highly experienced and proficient members were teamed with novice members who may be more deferential. Without assessments targeted at the teamwork dimensions at play

during the task, trainees and trainers may not be able to determine whether necessary teamwork skills have been developed. After their command team training, the trainees at the Combat Training Center would typically be deployed to various locations and integrated into other command teams. By this time, their teamwork competencies should have been honed. In the next section, we identify the key issues pertaining to team training assessments and identify the dimensions most relevant to wargaming (e.g., Cianciolo & Sanders, 2006; Cohen et al., 1996, 2000; McConnell et al., 2018). We also present example measures for the relevant teamwork dimensions assessable in a wargaming training simulator. These assessments of teamwork are in addition to the assessments of performance and learning objectives.

TEAM TRAINING PRINCIPLES

Regarding team tasks, many researchers acknowledge the distinction between taskwork, defined as individual tasks interacting with systems, tools, and machines, from teamwork, which concerns the interactions among team members as they work together to produce desired outcomes (e.g., Bowers et al., 1997; Crawford & Lepine, 2013; Marks et al., 2001; Rosen et al., 2008). In other words, "taskwork represents *what* it is that teams are doing, whereas teamwork describes *how* they are doing it with each other" (Marks et al., 2001, p. 357). The main principles recurring in the team training literature are that assessments should be made both at the individual and team levels, and include processes and outcomes (e.g., Rosen et al., 2008; Smith-Jentsch et al., 1998).

Unit of Analysis and the Aggregation Issue

Certain dimensions such as situational awareness, knowledge, and workload can exist both at the individual and team levels. In the training context, assessing them at both levels facilitates diagnoses, which inform the proper interventions. For instance, while a team-level assessment of situation awareness may help explain why a team failed to adapt to changes in the task environment, the individual-level assessment of situation awareness may reveal where the critical deficit lay, which in turn may call for retraining of only specific individuals instead of the entire team.

A separate but related issue concerns the aggregation of scores collected at the individual level to form the team-level score. Whether the team-level performance is calculated as a summed score, an average score, taking the highest/lowest range, or a standard deviation of individual team members' scores depends on the model of the team construct or how the construct is formulated and defined. Team constructs adhere to the compositional model when the construct is structurally and functionally the same both at the individual and team levels (Kozlowski & Chao, 2012). One such construct is team mental models, a type of team knowledge representing knowledge common to team members. Team mental models are thought to develop through team interaction and learning (Cannon-Bowers et al., 1993) and adhere to the compositional model (Kozlowski & Chao, 2012). For such constructs, the team score can be a simple aggregate of the individual scores. However, when the construct at the team level does not operate in the same way as it does at the individual level, then that team construct follows a compilation model. These constructs emerge from how individual members interact, such that the whole is often more than the sum of the constituent parts. For example, the performance of a mountain climbing team adheres to the compilational model since the weakest member sets the ceiling on team performance such that the team score may well be the score of the lowest scoring member (Kozlowski & Chao, 2012).

Team Constructs

In team training, it is important to assess both processes and outcomes since outcomes can be affected by a host of factors outside the purview of training, such as factors relating to the equipment or enemy capabilities. While assessed outcomes indicate performance deficiencies, they do not necessarily reveal areas to train and improve on. Command teams wargaming together may arrive at a valid solution or optimal course of action for a particular scenario through a flawed process, but the identification and correction of the flawed process would not be possible with the assessment of the outcome alone (Smith-Jentsch et al., 1998). Therefore, we reviewed research on teamwork conducted in medical and military domains that share important characteristics with the wargaming process. These include a relative lack of structure for tasks, the presence of a degree of uncertainty and time pressure, and the composition of teams with diverse expertise working together and adapting to changing circumstances. We organized the various factors and team dimensions into Table 1, which presents commonly cited types of teamwork constructs, descriptions, and examples. As expected, we found constructs or dimensions relating to team processes and outcomes and other types of constructs, all reflecting the complexity of the relationships among factors and constructs underlying teamwork and

team performance. There were moderating constructs, enablers, and emergent states. Team dimensions were also classified as being related to the affective, cognitive, behavioral aspects, or knowledge, skills, or abilities, among others. As expected, these types are not mutually exclusive, and many constructs can be classified as more than one type. For instance, team knowledge is a "cognitive" construct related to "knowledge."

Table 1. Types of Team Constructs

Construct Type	Description	Example(s)
Inputs	Team constructs present and assessable at the start of the task	*Team size, team orientation*
Processes	Constructs relating to how team members interact, the method, procedure, or steps by which outcomes are attained	*Communication*
• Transition processes	Activities that the team engages in between performance episodes where the primary work is done	*Goal specification, strategy formulation* (Marks et al., 2001)
• Action processes	Activities that occur as the team works towards their goals	*Monitoring team's progress, backup behaviors* (Marks et al., 2001)
• Interpersonal processes	Activities focused on managing interpersonal relationships	*Conflict management, motivating, affect management* (Marks et al., 2001)
Outputs/ Outcomes	Constructs relating to the results or consequences of the team's work, what the team produced	*Time taken to wargame, effectiveness of the selected course of action, mission plan*
Emergent States	Similar to "processes" in that neither are the intended result of the team's work. Dissimilar from "processes" because these are not steps, methods, or procedures, or pertain to the team member's interactions, but are constructs that denote qualities of the team that are observed as their affective, cognitive, and motivational states. Emergent states can be proximal outputs or by-products, which in turn can be inputs (Marks et al., 2001).	*Situation awareness, team cohesion, collective efficacy*
Moderators	Constructs that change the strength of an effect or relationship between two variables/constructs (Kenny, 2018b)	*Workload* affects which team processes are needed for effective team performance (Salas et al., 1995).
Mediators	Constructs or variables specifying how or why a particular effect or relationship occurs. They are intervening variables since they define the process that occurs to create the relationship (Kenny, 2018a)	*Team cohesion* mediates the relationship between team members' attitudes and team performance. Negative member attitudes affect performance through poor team cohesion (Mach et al., 2010).
Coordinating Mechanisms	Constructs that determine the manner in which other team constructs operate, or enable another construct to exert its impact. They could be mediator variables.	*Shared mental models, mutual trust* (Salas et al., 2005). Team members can only show backup behaviors if they have a *shared mental model* of roles.
Knowledge	Constructs pertaining to the theoretical or practical understanding of a subject	*Knowledge of wargaming, knowledge of command staff roles*
Skills	Constructs relating to learned capabilities acquired through practice	*Critical thinking skills, conflict resolution skills*
Attitudes	Constructs associated with emotions and feelings about or towards someone or something	*Team orientation, collective efficacy*
Affective/ Motivational	Constructs associated with emotions and feelings about or towards someone or something	*Collective efficacy, cohesion*
Cognitive	Constructs relating to cognitive processes or outcomes	*Situational awareness, transactive memory*
Behavioral	Constructs related to observable behaviors	*Adaptation*

TEAMWORK IN WARGAMING

Despite differences in terminology and application, several team constructs were common to the multiple teamwork models and frameworks we reviewed. When the constructs were collated, they clustered around several themes/ dimensions. Table 2 **Error! Reference source not found.**summarizes six teamwork dimensions deemed relevant to wargaming for the resulting working model. The operationalization of these teamwork dimensions in wargaming is discussed in the sections that follow.

Table 2. A Model of Teamwork Dimensions in Wargaming

Teamwork Dimensions	Definitions	References
1. Leadership	Providing guidance, direction, goal-setting, strategy formulation.	• Baker et al., 2005 • Cianciolo & Sanders, 2006 • Cohen & Thompson, 2001 • Dickinson & McIntyre, 1997 • Grossman & Feitosa, 2018 • Johnston et al., 1998 • Kozlowski et al., 2015 • Lepine et al., 2008 • Marlow et al., 2018 • Ramachandran et al., 2016 • Salas et al., 2005 • Smith-Jentsch et al., 1998 • Sottilare et al., 2018
2. Team Cognition	Possessing shared mental models of command and control, wargaming knowledge and team roles, transactive memory, situational awareness, critical thinking, adaptive and creative thinking.	
3. Information Exchange	Sharing of critical information, unique pieces of information, the extent of information elaboration, pushing up information, pulling information.	
4. Communication Quality	Using proper phraseology, understanding of military conventions in communication.	
5. Supporting Behaviors	Providing valuable feedback, engaging in backup behaviors, mutual performance monitoring, load-leveling.	
6. Team Orientation	Exhibiting team cohesion and motivation, supporting mutual trust, conflict resolution, and management, promoting open communication.	

Dimension #1: Leadership in Wargaming

In wargaming, the leader, such as the Executive Officer or Chief of Staff (COS), is both a decision-maker and a facilitator of the wargaming exercise since the staff members of the command team are each representing expertise for their respective functional areas. The leader orchestrates the activity and sets the pace and tone of the wargame, which consists of multiple "turns" as the team plays out the COA. For the first turn, leaders get all staff members on the same page by reviewing the mission and commander's critical information requirements, summarizing the known location of friendly forces and estimated locations of enemy assets within the areas of interest, and identifying operational timing. In each turn, as the leader initiates the discussion for each COA event, staff members contribute inputs related to their respective functional areas either on their own initiative or in response to leader prompting. Inputs may include decisions required for operational details or information related to possible following operations. The leader may also provide guidance for planning these follow-on operations. Behaviors indicative of leadership in wargaming can include laying out the plans on how a COA is to be war-gamed, assigning tasks to specific staff members, prompting staff members to provide inputs, keeping the team on task, and facilitating goal-setting by the team.

- Example Assessment: Observed ratings and counts of the Executive Officer's or Chief of Staff's expected behaviors indicative of affirmative leadership or lack of leadership.

Dimension #2: Team Cognition in Wargaming

Team cognition in wargaming can pertain to both knowledge and skills. Staff members must work closely with one another and integrate information from the different warfighting functional areas to produce a mission plan that capitalizes on the capabilities of each battlefield operating system while accommodating their needs (Cianciolo & Sanders, 2006). This necessitates staff knowing their role as well as the roles of others so that they understand the impact of any action and information required from each battlefield operating system. Such knowledge allows staff members to understand each other's information needs (Cannon-Bowers et al., 1995). Staff members must also share a certain level of common knowledge about wargaming to perform the task effectively as a team. This includes explicit knowledge of the formal wargaming procedure and doctrinal wargaming products. There is also a component of implicit or tacit knowledge for wargaming that fulfills not only explicit requirements, such as completing the synchronization matrix, but also the intent, such as longer-term implications of combat losses on the commander's decision-making (Cianciolo & Sanders, 2006). Team cognition can also include situation awareness, shared mental models, and transactive memory, which is the shared store of knowledge of who knows what in the team at different stages of the wargame (Sottilare et al., 2018).

Team cognition in wargaming also pertains to cognitive skills. These are demonstrated when the command team engages in critical thinking and analogical reasoning in gathering and processing large volumes of information, some of which can be conflicting or originate from sources of undetermined reliability. Staff members must work and sift through the data, bearing in mind the commander's intent, and synthesize them to produce the relevant information accurately and in a timely manner (Cianciolo & Sanders, 2006). Adaptive thinking skills also constitute part of team cognition and are an essential part of command decision-making, which often occurs under dynamic conditions of varying degrees of uncertainty due both to environmental events and enemy factors. A command team adept at adaptive thinking is more likely to create plans that are flexible with greater degrees of freedom to accommodate unforeseen events during execution (Cianciolo & Sanders, 2006). Analogical reasoning and critical thinking skills enable command teams to see similarities in different situations which can facilitate information processing and the use of heuristics. However, critical thinking must be exercised to identify when a pattern fails to persist, requiring further processing. Command teams must also be self-aware of their own deficiencies in thinking and regulate their own thinking. Metacognitive strategies come in play when they understand how they come to recognize patterns, whether they are seeking confirmatory evidence, and can regulate this process. They can identify the hypotheses that are formulated and assumptions that accompany them, as well as know when and how to test them by seeking out contrary indicators (Cohen et al., 1996, 2000).

- Example Assessment: Scores on the "Staff Roles Knowledge Assessment," an instrument that assesses the extent to which the respondent understands the various team roles (see Cianciolo & Sanders, 2006).
- Example Assessment: Responses to probing questions to measure shared mental models of situational awareness in the context of the wargaming scenario.

Dimension #3: Information Exchange in Wargaming

In wargaming, the workflow of staff members is reciprocally interdependent (Tesluk et al., 1997). This requires staff to share information effectively for the COA analysis. For each turn in the analysis, staff members, all of whom possess expertise in different functional areas, must exchange information synthesized to form an integrated plan. For example, a helicopter attack route may be initially chosen by an aviation lead, but inputs from a fire support lead and others may be necessary to ensure that the route is safe and deconflicted from other active battlefield events.

The quality of the information exchanged can lie in its level of detail and elaboration (Marlow et al., 2018), and/or criticality or centrality to the events being discussed. While the leader or others in the team may need to "pull" some of this necessary information, staff in an effective command team, in anticipating the information needs of others, would often "push-up" information instead. This not only helps the wargaming proceed more efficiently, but also ensures due consideration of information that may not be apparently relevant, but can make even the smallest, but significant impact on the analyses.

- Example Assessment: Observed ratings of task-related information sharing that are linked to expected information sharing behaviors in the context of the COA events.

Dimension #4: Communication Quality in Wargaming

The impact of using proper phraseology and adhering to military conventions in communications cannot be overlooked. Among the command team members, it is vital that communications are conducted appropriately not only to pass information effectively but also to maintain trust between participants. The use of appropriate communication methods may also reflect knowledge of military protocols and the skill of maneuvering within the organization to meet particular informational needs.

- Example Assessment: Observed ratings and counts of communications that do not adhere to military conventions or protocol.

Dimension #5: Supporting Behaviors in Wargaming

Members in high-performing teams often provide assistance to one another to ensure that team goals are accomplished successfully. They may offer backup help, taking over entire tasks from others when they are over-loaded, or help with a portion of the task, such as a subtask. Supportive behaviors can also take the form of timely reminders of what was already done or ensuring that the other is aware of what else s/he needs to have done (Smith-Jentsch et al., 1998). This latter form of supporting behaviors may be more common among members of the command team when they wargame, since members typically have their own functional area that they work within and are not likely to off-load entire tasks to each other. Supporting behaviors also frequently arise in military teams composed of members with different levels of expertise, where more experienced members may offer guidance to other team members even across different warfighting functional areas.

- Example Assessment: Observed ratings and counts of supporting or backup behaviors such as providing reminders or prompts to each other for their tasks.

Dimension #6: Team Orientation in Wargaming

The extent to which command team staff members collaborate and contribute to wargaming and the common goal of COA analysis is in part a function of their motivation to work as a team. Team motivation can often spur staff members to "go the extra mile" and volunteer information or participation that others can draw from or work with. Such occurrences can uncover critical information or analyses that may not have been actively sought after but can differentiate a mediocre wargame from an exceptional one. Team motivation is also valuable when any additional efforts by staff members can yield greater performance gains, such as working in the presence of battlefield chaos (Cianciolo & Sanders, 2006). Shared motivation is also an element of team orientation in wargaming, where it is important for team members to not only understand the decisions that are made in refining the COA, but also the reasoning and motivation behind those decisions, which can be related to overall team objectives.

- Example Assessment: Participants' responses to questions posed to measure shared motivation among the team that are related to a shared understanding of the rationale behind decisions made during wargaming.

OTHER CONSIDERATIONS IN ASSESSING TEAMWORK IN A WARGAMING TRAINER

Defining the behavioral indicators of these dimensions for a computer-based wargaming trainer requires both a top-down and bottom-up approach. Although the theoretically-grounded constructs and dimensions must drive assessment methods, the operationalization of the constructs depends on how the task is instantiated in the prototype trainer and how the team members execute the wargaming task within the trainer. The mechanisms for information sharing, communication, and how tasks are accomplished in the training prototype will determine the behaviors elicited. This led us to ask: Is there a mechanism for various team members to provide inputs even when they are not explicitly solicited? And, is there a way for members to be aware of the problems faced by others, and what kinds of supporting behaviors they can offer within the training environment? Some of these behaviors may be "collected" by the training system and contribute to measures that may be used in intelligent tutoring. For instance, when a trainee consistently fails to identify the appropriate functional area from which to obtain a specific type of information, then this may indicate a deficit in his/her knowledge of others' roles. When this is detected by an intelligent tutor, the trainee can then be enrolled in the appropriate remedial training. Assessment methods include automated scoring of directive

questions, automated observational analyses of formatted inputs and decisions collected from the wargaming exercise environment, and analyses of communication content such as team chat messages. Automated methods can also be augmented with human observers rating pre-defined behaviors using behaviorally-anchored rating scales and behavioral observation scales or checklists, respectively (Rosen et al., 2008). Other assessments are self-report measures that can be administered before or after the training, e.g., "How open was the team's communication during the wargaming task"? Most researchers recommend utilizing a range of methods for assessment of the same dimensions since each method has its inherent advantages and flaws (Rosen et al., 2008).

CONCLUSION

Wargaming is a critical team process that command teams must master in military decision-making. There is evidence from multiple reports and observations that it is one of the most difficult skills to train. This paper presents an applied teamwork model based on a synthesis of the key concepts and findings from research on team processes and training relevant to training wargaming in command teams. Even if the relevant constructs are identified, research indicates that the relationships among these constructs, as well as their relationships with aspects of team performance are complex and rarely one-to-one. Building on the identification of six main constructs or dimensions in a working team model for wargaming, future research operationalizing the model and assessment measures will provide further insight to contribute to the growing understanding of the art of teamwork in effective wargaming.

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