Accelerated Learning Model for Increased Tactical Decision-Making Effectiveness in Unstructured Situations

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ABSTRACT

Domain-specific expertise develops as individuals gain experience identifying recurring patterns through problem-solving over time. This study examines whether accelerated learning methods, grounded in Cognitive Flexibility Theory and Cognitive Transformation Theory, can enhance training efficiency for U.S. Marine Corps personnel making tactical decisions under uncertainty. The approach employs iterative, trial-and-error learning cycles in immersive, time-compressed decision scenarios where participants must achieve measurable performance goals. Conducted in collaboration with the USMC Basic School in Quantico, Virginia, the research trained officer candidates in Amphibious Ship Well Deck operations, convoy management, and Expeditionary Advanced Base Operations (EABO) using a purpose-built simulation. Each scenario emphasized mission planning and coordination with naval officers while confronting uncertain operational environments. The experimental model aimed to foster adaptable expertise by simulating real-world demands, enabling trainees to develop cognitive agility and maintain mission objectives despite ambiguity. Findings demonstrate a scalable method for accelerating complex tactical decision-making proficiency in ill-structured environments.

KEYWORDS

Accelerated Learning, learning models for accelerated Learning, Simulation based learning

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INTRODUCTION

Military leaders and decision makers often face challenges that come from the introduction of new missions, tactics, and personnel. Military training must address these challenges in a rapidly changing environment. Some years ago, the Defense Department's Science and Technology Advisory Group (DSTAG) called for a study of emerging concepts for rapid yet effective training that could aid military leaders as they sought to accelerate learning, especially in the domain of tactical decision making. (Andrews, 2009). Tactical decision-making expertise is difficult to learn because there are so few opportunities to develop tactical plans and execute them in formal training settings and most novices (in this case junior officers) do not get opportunities in real life until later in their careers. (Chi, M.T.H., Glaser, R., and Farr, M.L.(Eds.) (1988).

To address DSTAG's questions, a multi-service team of training experts was assembled. The team consisted of training research psychologists and training developers from the following organizations, (Office of the Director of Defense Research and Engineering, Air Force Research Laboratory, the Army Research Institute for the Behavioral and Social Sciences, and the Naval Air Warfare Center – Training Systems Division), The team examined the existing research literature and presented to the DSTAG their findings and recommendations. The researchers determined that two key learning theories were applicable in accelerating the acquisition of expertise: Cognitive Flexibility Theory and Cognitive Transformation Theory. In this study we explore the following research questions:

- Does repeated exposure with micro-decision feedback increase the proportion of expert/near-expert choices from Time 1 to Time 2?
- Does this improvement persist even as mission complexity increases?
- Do specific tagged capabilities (e.g., communication, setting an example) show differential improvement?

COGNITIVE TRANSFORMATION THEORY AND COGNITIVE FLEXIBILITY THEORY

Cognitive Flexibility is the "ability to represent knowledge from different conceptual and case perspectives and then, when the knowledge must later be used, the ability to construct from these different conceptual and case representations a knowledge ensemble tailored to the needs of the understanding or problem-solving situation at hand." (Spiro, Feltovich, P.J., Jacobson, 1992, p. 58).

Cognitive Flexibility Theory Core syllogism

- Learning is the active construction of knowledge, the elaboration and replacement of mental models, causal stories, or conceptual understanding.
- Training must support the learner in overcoming reductive explanations.
- Reductive explanation reinforces and preserves itself through misconception networks and through knowledge shields.
- Advanced learning is the ability to flexibly apply knowledge to cases within the domain.

Therefore, instruction by incremental complexification will not be conducive to advanced learning.

Therefore, advanced learning is promoted by emphasizing the interconnectedness of multiple cases and concepts along multiple dimensions, and the use of multiple, highly organized and multi-modal representations.

Cognitive Transformation Theory (Klein and Baxter, (2009) is similar. "We may attempt to define the cues, patterns and strategies used by experts, and try and develop a program to teach people to think as experts. A different approach to skills training is to teach people how to learn like experts" (Klein, 1997, p. 37).

Cognitive Transformation Theory Core syllogism.

- Learning is the active construction of knowledge, the elaboration and replacement of mental models, causal stories, or conceptual understanding.
- All mental models are limited. People have a variety of fragmentary and often reductive mental models.
- Knowledge shields lead to wrong diagnoses and enable the discounting of evidence.
- Training must support the learner in overcoming reductive explanations and constructing adaptive mental models and approaches.

Both theories converge on the idea that advanced expertise emerges from repeated, feedback-rich decision cycles in realistic, ill-structured scenarios. In this study, we test whether repeated exposure with micro-decision feedback increases the proportion of expert-level decisions across iterations, even as mission complexity increases.

To operationalize these theories, we developed a virtual simulation environment that mirrors real-world tactical challenges. FutureView™ is a domain-agnostic 3D virtual simulation platform that supports no-code mission authoring, micro-decision scoring, and intelligent agent behaviors as well as detailed behavioral tracking.

Specifically, for this study, we incorporated both CFT and CTT and operationalized them through a virtual world experience that provides an openness of the solution space with immediate feedback for the user. The user must achieve an over-riding non-negotiable goal (in this case mission success) in an unfolding situation, determining their own actions at each stage. During this experience, every micro-decision is scored against a novice to expert model for that domain. The score is determined by where it falls on the novice-expert continuum (DiBello, L., and Missildine, W. (2011). While going through the simulation, the user experiences the immediate feedback in low density form; in this case every micro-decision results in on-screen traffic lights where "green" is expert, and "red" is either the wrong approach or something a novice would do. The consequences of both good and bad decisions also play out. In this simulation, for example, an officer making a bad call may have the order overridden, may be reprimanded, or face dire consequences. Failure to plan for eventualities can result in a change in the opportunities of unfolding action. Meanwhile, the scoring details are collected in the technology's backend, and the user gets a comprehensive feedback report after the exercise. (Rothwell and Kazanas, 2004).

PRACTICAL BENEFITS FOR MILITARY DECISION MAKERS OF ACCELERATED LEARNING CAPABILITY.

This research project's outcomes will help military decision makers with:

- instructional guidelines for rapidly constructing relevant instructional approaches for tactical decision making. (Ward, Suss, and Eccles, 2009)
- a skill measurement system tailored for relevant decision-making competencies that is automated and objective. (Stazewski, 2008)
- synthetic training environments that allow these skills to be trained anywhere the trainees are located.
- synthetic environments that can be used to conduct mission rehearsals that are too risky to rehearse in another way.

RESEARCH METHOD

Volunteers for this study were second lieutenants at The Basic School (TBS), United States Marine Corps, Quantico, Virginia. The research focused on training in Amphibious Ship Well Deck operations, convoy operations, and Expeditionary Advanced Base Operations (EABO) using the FutureView™ platform, a 3D immersive virtual environment grounded in CTT. The scenarios were designed to provide officers with experience making tactical decisions for these mission types, in coordination with naval officers, while managing uncertainty and preserving mission goals. Learning objectives and the measurement system were developed jointly with TBS leadership, using the leadership evaluation criteria currently employed by the school.

Accelerated Learning Development Process

Study missions were authored by TBS instructors, who, with technical support, entered them directly into the FutureView™ platform using its No-Code scenario creation and editing tools. This capability enabled rapid prototyping and near-instant modification of scenarios without requiring programming or game design expertise, thereby supporting agile instructional design. A further capability of the platform is its "intelligent agents" system, which allows users to assign properties to objects and AI-controlled characters so they can act autonomously and adapt to participant decisions. These agent behaviors are also specified via the No-Code Editor, facilitating iterative refinement of mission flow, challenge structure, and scoring across successive playthroughs. For conceptual clarity and ease of revision, missions were organized into discrete "chapters" or scenes, (i.e., discrete scenes with localized goals and consequences) which made progression more transparent and localized edits more manageable. TBS staff specified several design requirements:

- reinforcement of the orders process taught in the Basic Officer Course (including warning orders, an intelligence briefing, and a five-paragraph order)
- opportunities for students to analyze information, set priorities of work, conduct reconnaissance and complete missions
- an operational environment that presented significant uncertainty and required executive-level decision making in accordance with the commander's intent
- a mission flow that began aboard ship with planning and interactions with naval personnel.

Mission content drew on TBS amphibious operations coursework, motorized operations coursework, EABO coursework, and a specific request to incorporate inform/influence messaging. Rather than presenting discrete "lessons," the scenarios were structured as unfolding and connected experiences in the context of a larger mission. Students confronted situations that required them to apply what they had learned. The simulation's opportunities and sequence of events were designed to depend entirely on student choices. FutureViews™ intelligent agent system adapts dynamically, creating a tailored experience for each participant. For example, two students starting with the same mission profile could reach the same conclusion, with one completing it in 20 minutes and about 60 micro-decisions, while another required over an hour and more than 100 micro-decisions, many of them corrective. The latter student received more "novice" or "intermediate" scores and a lower overall mission success score. However, across participants, repeated exposure and feedback pulled learners forward along the expertise continuum regardless of mission complexity.

Scenarios were generated through a multi-step process: (1) domain experts designed the missions and authored them in FutureView™; (2) a learning materials audit with TBS leadership validated scoring and tagging decisions; (3) scenario framing added strategically important "injects" and consequences; and (4) simulations were validated with SMEs to confirm that the missions were realistic and could plausibly unfold as depicted. The process began with an open problem-framing discussion in which the client identified training gaps, both in training support and in learning mastery. Based on these gaps, the development team and TBS identified training evolutions suitable for implementation in FutureView, and TBS staff designed missions to provide reality-analogous experiences that addressed those gaps.

A subsequent audit of classroom and field exercise materials ensured alignment with Service requirements and continuity within the TBS learning continuum. Terminal Learning Objectives (TLOs), Enabling Learning Objectives (ELOs), and Training and Readiness (T&Rs) standards were identified and confirmed with TBS leadership. The development team then helped translate TBS guidance on exemplary missions, scenario context, injects, and difficulty into a structured process for entering content into FutureView™.

Tagging Micro-Decisions

Each decision option presented to students was alphanumerically coded in accordance with the TBS evaluation rubric. Nine categorical tags and one aggregate "performance" measure were used. Examples of categorical tags included “judgment,” “communication skills,” and “proficiency.” For each option, the relevant categories were identified (allowing for overlap), and the option was rated on a five-point novice-to-expert scale. Because the subjects were lieutenants, the minimally acceptable performance level was set at Level 3, reflecting expected baseline competence. For example, a minimally acceptable “judgment” option might be coded “J3”; if the same option also met TBS criteria for proficiency, it could be coded “J3, P3.” The overall performance score was determined by a simple mean across the nine categorical codes. These tags enabled analysis of how often participants chose options aligned with expert-level judgment, communication, and other key competencies across repeated exposures.

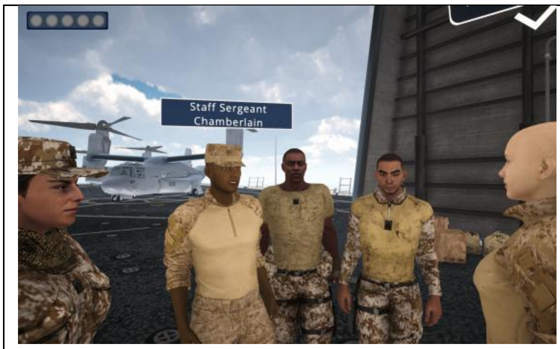
Due to the “intelligent agent” capability in the simulation, students could experience immediate positive or negative consequences for decisions and also encounter delayed consequences of earlier choices in later chapters, including second- and third-order effects. This design feature was essential to TBS’s goal of fostering forward-thinking, critical decision makers. The final development step was recursive validation: simulations were piloted at the ACSILabs facility and at the client site. Because of the platform’s agile architecture, missions could be adjusted in near real time during design meetings with TBS staff and SMEs.

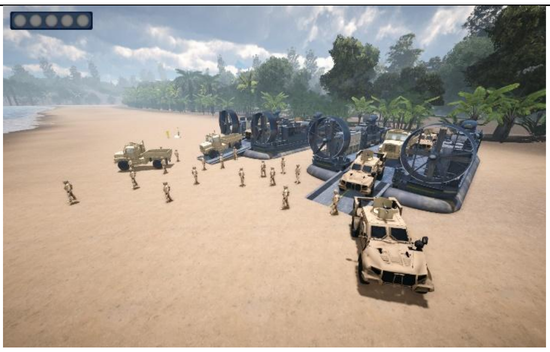
Depending on their decisions, students experienced different aspects of the simulation, including corrective feedback from non-player characters (NPCs), environmental repercussions, or relatively frictionless progress when they intuited optimal paths, thereby approximating real-world interactions and ramifications.

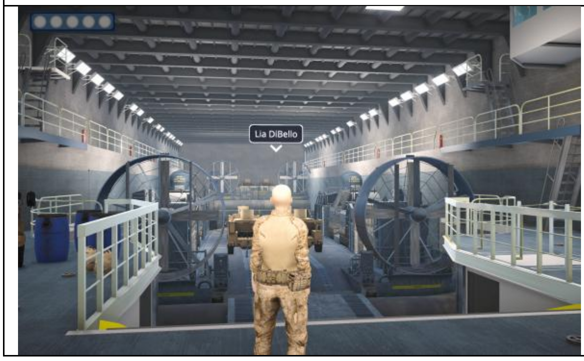
Measurement Model

The platform supports automated behavior tracking in its backend. Prior research indicated that tracking micro-decisions and providing immediate, low-density feedback (traffic lights in this study) is central to CTT methods and to testing hypotheses about accelerated learning. Consequently, granular behavioral tracking capability was built into the technology. Because the expert model is not always fully specified in advance in this type of study, the scoring scheme used to represent expert performance can be revised in the platform’s backend via the No-Code Editor.

FutureView™ was designed as a domain-agnostic tool capable of accommodating any domain of expertise in which SMEs can agree on what constitutes an “expert” move or intuition. For this study, a five-point Dreyfus novice-to-expert scale (Dreyfus, 2004) was applied to the ten categories TBS uses to evaluate students. Each micro-decision option was assigned a Dreyfus level and tagged with the relevant categories (e.g., decision-making ability, effectiveness under stress).[23]







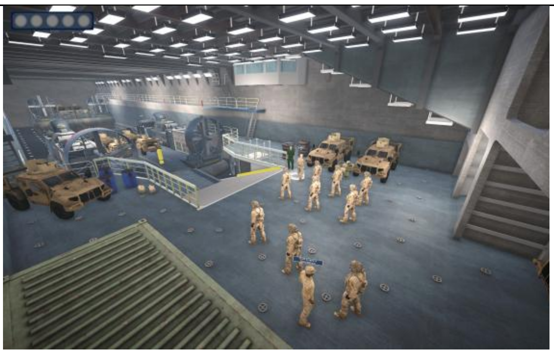


Figure 1. Screenshots of phases of the Missions

Participants and Procedure

The simulation was piloted with three cohorts of Marines at TBS in Quantico. Due to constraints in the relationship with the Marine Corps, the research team was not permitted to collect demographic information (e.g., age, performance in the program) at the individual level. Each cohort consisted of 12–25 Marine second lieutenants at various points in the TBS POI: some had graduated and were awaiting Military Occupational Specialty school, some were partway through the Basic Officer Course (BOC) POI, and others were nearing graduation. The first cohort (n = 16) completed an early version of the first mission. The second cohort (n = 20) completed a more complex version of the same mission. The third cohort (n = 25) completed two highly complex missions, each of which could require up to 200 micro-decisions per hour.

As noted, the research did not compare absolute decision counts or specific paths taken. Instead, analyses focused on the total number of decisions made from the available set and the *proportion of choices at each expertise level*. This approach was necessary because paths were intentionally unique for each student and missions evolved over the course of development. The underlying hypothesis was that qualitative choice—from novice-like to expert-like—would be influenced by participants' expertise. This proportional method has been used in prior research examining expertise in user-defined paths (DiBello, 2019).

DATA ANALYSIS AND RESULTS

Analyses examined how participants moved up the expertise scale from time one to time two, defined as their first and second exposures to the mission environment on separate days, averaging 24 to 48 hours in between sessions. The central question was whether the proportion of "expert" or "near-expert" choices increased across these repeated exposures. CTT holds that iterative, feedback-rich trial-and-error cycles support both the unlearning of erroneous assumptions and the acquisition of more adaptive cognitive strategies.

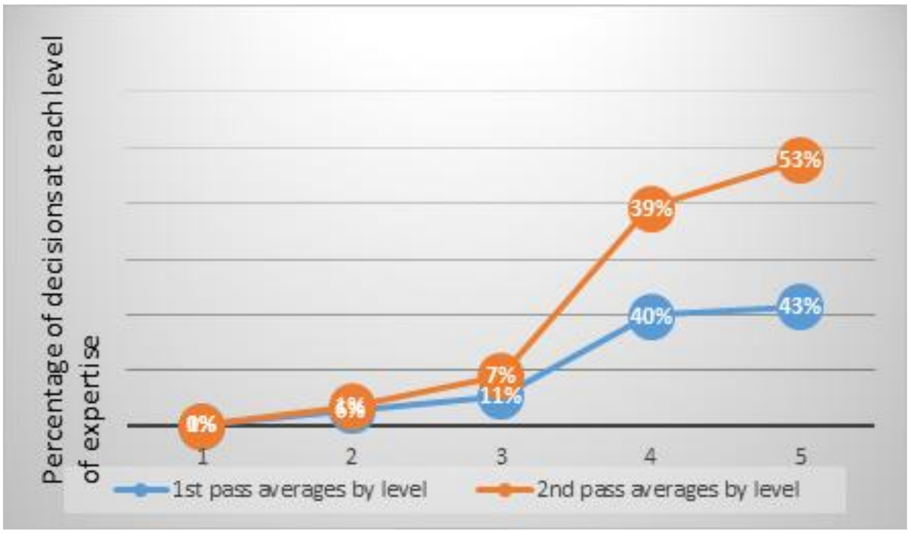


Figure 2. shows a clear upward trend in expert-level decisions after repeated exposure

Analyses focused on within-subject changes in the proportion of expert-level choices between the first and second exposure. As illustrated in Figure 2, the average percentage of choices at each level shifted toward more expert-like responses from time one to time two across all participants, using the five-point novice-to-expert scale. A t-test examining the impact of feedback showed a statistically significant increase in "expert" or "near-expert" choices on the second attempt for all groups combined, regardless of mission or complexity N = 61 across three cohorts (n1 = 16, n2 = 20, n3 = 25) ($t(25) = -4.91$, $p < .001$, $SD \approx 0.046$). For the third cohort, this pattern was also observed on both missions ($t(24) = -4.06$, $p < .001$, $SD \approx 0.09$). Because mission paths and decision opportunities varied by learner, proportions at each expertise level provided a path-independent index of performance. The pattern of movement up the scale was similar across cohorts, irrespective of mission complexity. These results indicate that repeated exposure significantly improves expert-level decision-making, even under increasing complexity

Results from the cognitive capability tagging were more difficult to interpret. In general, students drew on all of the tagged capabilities, but as a group they tended to fall short in two areas: setting an example for others and communication. Given the pervasive nature of this pattern, this suggests limitations in the scoring scheme or the number and nature of opportunities to demonstrate these capabilities, rather than a true deficit in the cohort. E.g., there may have been relatively fewer decision points tagged with these capabilities.

Survey results

All the participants could also voluntarily fill out a survey on their experience. We desired to get feedback on the user experience. A limitation here is that these surveys were voluntary and descriptive and not all students had time to fill them out. Also, the purpose of the survey was to evaluate the subjective experience of students, not any measurable learning based on how they performed in time two vs. time one. These self-reports complement but do not replace performance-based measures. There were 34 complete surveys in total.

General results from the survey

- All participants reported a feeling of immersion. E.g., they felt they were "on the USS San Diego".
- All agreed that the activities were realistic, challenging and engaging.
- All appreciated the instant feedback after each decision.
- All felt better prepared for a similar mission in real life.
- All agreed the planning portions provided valuable insight into the whole mission and everyone's role.

Overall, participants perceived the training as realistic, engaging, and beneficial for real-world mission preparation**.**

LIMITATIONS

Experimental Design Constraints

The original study design called for a control group that would receive only classroom-based instruction on the target concepts, allowing comparison of their performance with that of a cohort trained using the FutureView™ platform. This structure was intended to assess both the impact of Cognitive Transformation Theory (CTT) and the efficacy of scalable, simulation-based training that minimizes reliance on subjective evaluation.

However, the United States Marine Corps (USMC) declined this experimental design. Their primary interest lay in accessing more advanced simulation-development technology to meet their modernization goals, and secondarily, in training Marines on content not yet included in the current Program of Instruction (POI). While their enthusiasm for the FutureView platform led them to authorize volunteer participation, they did so only under these modified conditions.

Similar constraints have been noted in previous applications of CTT (e.g., DiBello 2019 for a summary), requiring analytic adaptations to operate under less-than-ideal experimental control. In this study, the analytic emphasis therefore shifted toward examining the effects of repeated practice within a feedback-intensive learning environment grounded in CTT. The focus was on within-subject changes over time. Consistent and practically significant learning gains were observed across iterations, even as subject-matter experts (SMEs) increased mission complexity. Notably, even the nominally "simple" missions proved cognitively demanding.

Lastly, given that all participants were Marine second lieutenants at TBS, generalization to other Services, ranks, and joint environments remains to be tested.

SME Variability

A further limitation concerned the variability of SME experience. While each SME was a seasoned leader and combat veteran, their individual backgrounds and areas of expertise differed considerably. As a result, the study relied on peer and supervisory judgment to substantiate SME status rather than on a standardized, externally validated criterion of expertise.

CONCLUSION

Our findings demonstrate that training based on Cognitive Transformation Theory—where participants are "pulled forward" through feedback that highlights the differences between their decision processes and expert performance—is highly effective. The FutureView™ platform aligned closely with this approach, supporting dynamic and adaptive feedback mechanisms.

The Basic School (TBS) leadership independently designed and implemented missions with only technical support. Each mission required coordination with Naval officers for planning and communications; execution of a Rehearsal of Concept (ROC); preparation of convoy and amphibious equipment; and development of a Warning Order along with other critical operational components. A random event generator introduced uncertainty into each scenario, compelling participants to adapt to unanticipated developments while still achieving mission objectives. Examples of injections: a bridge that may not hold the weight of convoy vehicles, vehicle breakdown, various events involving local civilians, planned routes not available, issues with communication equipment.

TBS also integrated its Leadership Feedback Form into the simulation to automate individual evaluations. The No-Code editor allowed easy adjustment of scoring parameters as requirements evolved, embedding automated assessment directly into the scenarios, making reports instantly available to both instructors and students. The missions supported both single-player and multiplayer modes; TBS selected the single-player configuration for testing, in which AI agents filled the remaining roles.

The project provided clear evidence that TBS could accelerate learning in complex domains using this CFT–based approach. As a result, the school intends to incorporate the developed training into its formal Program of Instruction beginning in 2025. To date, 660 Marines have completed the simulations.

Future research will examine the model's effects on learning retention, a critical complement to initial skill acquisition. Based on results from non-military applications, we anticipate that the CFT models supported by the FutureView™ platform—will enhance both the depth and durability of learned competencies.

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