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MODERN PEDAGOGICAL TECHNOLOGIES IN MILITARY EDUCATION: SCIENTIFIC-METHODOLOGICAL FOUNDATIONS AND PRACTICAL INNOVATIONS

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Abstract:
This article analyzes the conceptual and methodological foundations of modernizing the military education system under the conditions of 21st-century digital transformation and the VUCA and BANI world models. Moving away from traditional reproductive teaching methods, the study highlights the evolution of technologizing military education, drawing upon the theories of socio-constructivism, cognitive dissonance, and multimedia learning. The article provides a profound scientific justification for the military-practical integration of interactive, project-based (PBL), problem-based learning, digital technologies (AI, GIS, VBS simulators), and “Flipped Classroom” models through specific tactical examples (FPV drone attacks, hybrid threats, autonomous defense projects).

Keywords: Military pedagogy, pedagogical technology, evolution, social constructivism, Bloom’s taxonomy, project-based learning (PBL), problem-based learning, gamification, Virtual Battlespace (VBS), flipped classroom, cognitive dominance, Auftragstaktik.

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Introduction

The 21st century has entered the history of human civilization not only as an era of sharp technological convergence and the Fourth Industrial Revolution ("Industry 4.0"), but also as a period in which the gnoseological (epistemological) paradigms of the education system are undergoing radical transformation. The exponential growth of information flow (the information explosion) and its synergetic integration with the phenomenon of globalization have deconstructed traditional educational boundaries of space and time.

Digital transformation (digitalization) within the socio-economic and structural strata of society has completely altered the conceptual architectonics of the modern labor market. The manifestation of contemporary world models such as VUCA (Volatility, Uncertainty, Complexity, Ambiguity) and BANI (Brittle, Anxious, Non-linear, Incomprehensible) into reality has necessitated a re-evaluation of the fundamental concepts of the educational socium. From a scientific perspective, military pedagogy must rely on L. Vygotsky's "Social Constructivism" and B. Bloom's "Cognitive Taxonomy." That is, information is not merely passively memorized by the cadet; rather, they are elevated to higher-order thinking levels (analyzing, evaluating, creating).

In today's rapidly changing era of globalization, the education system, like any other field, demands continuous updating and development. Traditional educational methods based solely on information delivery are being replaced by modern pedagogical technologies that stimulate student activity and develop their creative and logical thinking. Modern pedagogical technologies represent a complex of methods, tools, and processes utilized to achieve educational objectives, wherein the learner's personality, interests, and capabilities are placed at the center.

Today's economy requires learners to display not only deterministic (narrow-scoped) professional knowledge ("hard skills"), but also adaptive, creative, systems-thinking-based meta-competencies and "soft skills."

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For modern didactics, abandoning the reproductive approach—which is oriented toward merely transmitting a ready-made, static information base and has now become ineffective—and transitioning to a competency-based educational model stands as an imperative of our time.

Consequently, the strategic vector of the education system is to shape a divergent personality capable of independent cognitive activity, possessing heuristic potential, able to solve problems through non-standard algorithms, and integrated into the concept of "lifelong learning" based on continuous self-development.

Achieving these global socio-pedagogical goals requires the scientific and conceptual restructuring and design of the educational process. From a methodological standpoint, pedagogical technology is not merely a mechanical aggregation of teaching methods or technical tools; rather, it is a codified scientific-methodological methodology for designing, implementing, and systematically monitoring the holistic process of teaching, knowledge acquisition, and personal development. This is conducted by factoring in the laws of interaction between human resources (the interaction between educator and student) and intellectual-technical tools to optimize educational formats, guarantee efficiency, and diagnostically evaluate ultimate outcomes. A technological approach to the educational process serves as a factor that ensures the algorithmization of didactic processes, their reproducibility, and the alignment of the final result with intended objectives.

The concept of pedagogical technology and its didactic substance is not a static phenomenon formed overnight. It is an epistemological category that has evolved in close connection with the economic, philosophical, and technological progress of society. Analysis of scientific-pedagogical literature and historical-textbook retrospectives demonstrates that this field has progressed through three primary conceptual stages, spanning from the simple introduction of technical tools into the classroom to the fundamental digital transformation of the educational process.

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1. The "Technology in Education" Stage (Mid-20th Century): An Instrumental-Empirical Approach. This stage historically coincides with the post-World War II era, characterized by the rapid growth of production and technology. During this period, "technocentrism" predominated in pedagogical science, where the focus centered on the technical equipment of the lesson rather than the instructional methodology itself.

Methodological essence: The educational process was conceptualized mechanically, and technical tools (audiovisual devices, tape recorders, movie projectors, early mechanical teaching machines, and computing equipment) were regarded merely as auxiliary, illustrative elements of the lesson.

Characteristics and limitations: In this stage, the internal structural architecture of the lesson remained unaltered—the teacher continued to serve as the sole source of information, while technology merely facilitated the delivery of data to a certain extent. Scientifically, this era can be termed an "instrumental approach," as technology influenced only the external shell rather than the core of the educational concept.

2. The "Pedagogical Technology" Stage (Late 20th Century): Cybernetic-Systemic and Algorithmic Design. Beginning primarily in the 1960s and 1970s, it became evident that simply demonstrating information to learners did not yield the expected efficiency. Consequently, a shift occurred from the simple technical equipment of education to its systemic design (pedagogical design). This shift was profoundly influenced by the concepts of cybernetics, systems analysis, and behaviorist psychology.

Conceptual shift: The focus of attention moved from the "teaching tool" to the problem of "algorithmizing the instructional process." The interaction between the educational object and subject was restructured based on the principles of cybernetic management.

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As for fundamental scientific foundations, Benjamin Bloom's taxonomy established a system for classifying educational objectives across cognitive, affective, and psychomotor domains in a strict hierarchical form (knowledge, comprehension, application, analysis, synthesis, and evaluation). This, in turn, enabled the measurement of educational quality.

Meanwhile, V.P. Bespalko's concept advanced the theory of strictly designing didactic processes and guaranteeing their outcomes. According to this view, pedagogical technology is the blueprint of a specific pedagogical system implemented in practice, which must ensure the reproducibility of the lesson and achieve a pre-planned, guaranteed result, regardless of the instructor's individual mastery.

The achievement of this stage was the elevation of education from the level of an art to the level of a scientific-pedagogical production that relies on regularities, is diagnostically evaluated, and is algorithmized.

The "Intellectual and Digital Pedagogy" Stage (21st Century): Termed as the synergetic-network and ecosystemic paradigm, under the conditions of the information age and post-industrial society, technologies based on strict, rigid (inflexible) algorithms began to reveal their destructive (limiting) aspects. Instead of the unification (standardization) of human capital, a need arose to prioritize individual uniqueness and creativity.

Evolutionary Chain]: Technical Tool (Mid-20th Century) ──> Rigid Algorithm (Late 20th Century) ──> Flexible Ecosystem (21st Century)

Student-Centered Approach: In the contemporary stage, the learner is no longer a passive object of the process but has become its active subject and content creator. The educational environment has assumed a flexible, non-linear form based on the principles of socio-constructivism and synergetics.

Education in a hybrid and convergent environment is no longer confined solely to the physical classroom but has synthesized with the digital space (blended learning, distance, and hybrid learning models have emerged).

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Artificial Intelligence and Intellectualization: Today, technology is not a tool that replaces the teacher, but rather serves as their intellectual partner. Big Data analysis, predictive pedagogy, and neural networks generate adaptive learning trajectories in real-time, based on the personal psychophysiological profile of each learner. The educational environment has expanded beyond the traditional institution, transforming into a large and open digital learning ecosystem.

The historical evolution of pedagogical technologies demonstrates a regular pattern of movement from simple empirical tools toward complex intellectual ecosystems. While in the first stage technology merely decorated education and in the second stage it managed it, in the third—contemporary—stage, technology serves to fully personalize education and unlock human inner potential to the maximum. This dynamic of historical tendencies shows that the fundamental basis of future pedagogy will consist of a symbiosis between digital intelligence and a humanistic approach.

1. Interactive Learning Technologies. Interactive methods are based on L. Vygotsky's "Zone of Proximal Development" and Kurt Lewin's "Group Dynamics" theories. Scientific research indicates that when information is merely listened to in the form of a lecture, only 5–10% of it is assimilated, whereas through independent discussion and mutual cooperation, 50–75% is retained. In military pedagogy, these methods ensure the transition of cadets from an authoritarian (solely awaiting orders) thinking model to a constructive-analytical model, thereby forming skills for horizontal communication and collective decision-making in the future officer.

Extended methods and their military-practical integration:

A) "Brainstorming" – Military Variant: "Generation of Non-Standard Tactical Ideas". The traditional military hierarchy (rank and position echelon) can sometimes limit the creative ideas of young officers. "Brainstorming" technology temporarily removes this barrier during the instructional process.

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Practical process: Cadets gather in the staff room. The instructor (acting as the chief of staff) presents a real military problem: "A swarm of low-flying enemy FPV drones is preparing to attack our supply column. We have no electronic warfare (EW) equipment. How do we preserve our column?"

Rules and analysis: In the first stage, any idea, even if it seems completely insane, is accepted without criticism (for instance, someone suggests creating a local microclimatic smoke screen, while another proposes acoustic jamming). In the second stage, these ideas are passed through a scientific-military filter, and the most optimal strategy is selected. This method trains officers to break free from rigid templates under unexpected asymmetric warfare conditions.

B) "Clustering" (Mind-Mapping/Clustering) – Military Variant: "Systemic Visualization of Hybrid Threats". A cluster is a didactic tool that enables the systematization of scattered data into a single logical chain and illustrates cause-and-effect relationships.

Practical process: On the instructional board or digital touchscreen, cadets place "The Enemy's Covert Hybrid Attack" as the central concept. Branches are then extended from it: Cyberattacks, Information-Psychological Operations (fakes), Sabotage Groups, and Economic Sabotage.

Tactical deepening: Under each branch, cadets formulate the counter-actions of their respective units. For example, under the "Information-Psychological Attack" branch, measures to strengthen ideological immunity among the personnel are recorded, while for the "Cyberattack" branch, an algorithm for switching communication systems to backup frequencies is written. In this lesson, cadets learn to look at reality from a "global and systemic" perspective rather than in fragments.

D) Boomerang Method – Military Variant: Peer-to-Peer Teaching and Staff Rotation". This method is based on the principle of "learning to teach." Each cadet becomes an expert in a specific narrow field and returns to teach their own group.

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Practical process: The large class is divided into four small groups (crews/units). They are given a general topic regarding the modern tactics of foreign armies. However, each group independently researches only one component of the topic: Group 1 – Enemy engineering fortifications in urban areas; Group 2 – Their night combat capabilities; Group 3 – Logistic supply; Group 4 – Communication systems.

Boomerang effect: Group members disperse and explain their designated topics to members of the other groups (the boomerang is thrown). Ultimately, all cadets reunite and draw up a single operational plan on a shared map to locate the enemy's weak point (the boomerang returns). This method enhances the officer's proficiency in processing a vast amount of cognitive information in a short period and conveying it to the team.

Systemic conclusion: Interactive technologies elevate military education from the stage of merely "memorizing" information (I know) to the stage of analyzing and transforming it in practice ("I understand and can apply"). This ensures that the intellectual capacity built in the classroom directly yields high results on combat training grounds.

2. Project-Based Learning (PBL). Scientific foundation: PBL technology is based on John Dewey's concept of "learning by doing" and William Kilpatrick's "project method." From cognitive and andragogical standpoints, this method develops the cadets' ability to synthesize various disciplines (tactics, military topography, engineering training, military economics, and psychology) around a single practical goal (the highest stage of Bloom's taxonomy), rather than merely accumulating disjointed knowledge. In this process, both the individual's professional skills (hard skills) and vital systemic competencies (soft skills—leadership, time management, proper resource allocation, and collective accountability) are shaped in parallel.

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Extended military-practical integration and project examples:
A) "30-Day Autonomous Defense System of a Strategic Area" Project (Tactical-Engineering Integration). Cadets transform the theoretical knowledge acquired in lectures into a large-scale, long-term collective project.
Practical task and research: A group of cadets (acting as a provisional staff of 5–6 members) is given a map of a mountainous or urban area with real geographical coordinates and terrain details. Their task is to "Develop a 30-day autonomous defense project for a strategic asset located in Area N under conditions of an enemy force attack."
The step-by-step scientific structure of the project:
1. Geographical and climatic analysis: Cadets study the terrain, climatic conditions, and technical capabilities of the potential enemy from a scientific-intelligence perspective.
2. Logistical and economic calculations: The volume of ammunition, food, fuel, water, and medical supplies required for a 30-day defense is calculated based on mathematical formulas.
3. Engineering and tactical planning: Engineering fortifications, minefields, hidden passage routes, and firing points are mapped digitally or graphically.
Project Defense: At the end of the exercise, the group defends its project before the "Military Council" (the faculty panel) using 3D models and presentations. Cadets are required to justify every tactical decision with military regulations and scientific calculations.
"B) "Sustaining Battalion Operations under Cyber Threats" Project (Operational Management and Soft Skills). This project tests the future officers' ability to work in a team under extreme time constraints and high responsibility.
Allocation of roles and hierarchy: Within the group, cadets distribute roles among themselves: "Project Leader" (Battalion Commander), "Chief Analyst" (Chief of Intelligence), "Technical Officer" (Chief of Communications and EW), and "Logist" (Chief of Technical/Logistic Support).

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Time management and psychological pressure: The project deadline is strictly enforced. During the process, the instructor injects unexpected "inputs" (e.g., "The supply route has been hit by an enemy cyberattack, communications are down"), requiring immediate revision of the project.

Soft Skills impact: Cadets learn to manage intra-group conflicts, listen to others' perspectives, and embrace collective accountability. This is because the success of the project does not depend on a single individual but on the synergetic actions of all members. Cadets realize in practice that a single mistake by the logistics officer could lead to the failure of the entire battalion project.

Systemic conclusion: Project-Based Learning (PBL) breaks the stereotype of "disjointed subjects" in higher military educational institutions. It instills in future officers the skill to view the planning of military operations not as mechanical work, but as a large-scale management project rooted in deep scientific-analytical, engineering, and economic foundations.

3. Problem-Based Learning (PBL / Problem-Centered Instruction)

Scientific foundation: Problem-based learning relies on Leon Festinger's theory of "Cognitive Dissonance" and Jean Piaget's laws of "Accommodation and Intellectual Adaptation." When a cadet confronts a contradictory situation without a ready-made solution or template, cognitive discomfort (dissonance) occurs in their brain. The need to resolve this problem stimulates brain activity, forcing it to seek new, non-standard heuristic hypotheses. In military didactics, this method rescues cadets from the stereotype of "templated tactical thinking" and drastically increases their cognitive flexibility and critical thinking indices.

Extended military-practical integration and problem scenarios:

A) "Tactical Dilemma under Conditions of Ambiguous and Contradictory Data" (Intelligence and Operational Command)". Instead of delivering a ready-made lecture or providing a clear-cut layout of the simulated enemy, the instructor provides the group of cadets with an intelligence packet containing contradictory and incomplete reports.

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Problem scenario (Conflict): “The enemy is advancing toward the asset you are defending. According to signals intelligence (SIGINT) data, the enemy will launch the main strike from the east. However, aerial reconnaissance (drones) has detected tank movements and deceptive maneuvers in the western direction. Concurrently, human intelligence (HUMINT) obtained from the local population indicates that the enemy intends to bypass via the northern mountain route. Your reserve forces are sufficient to seal off only one direction.”
Independent research and hypothesis generation by cadets: Cadets cannot apply standard regulation rules because the situation is completely ambiguous. They analyze the reliability coefficient of each information source, attempt to decode the enemy's cognitive model (deception tactics), and formulate alternative hypotheses. In the process of finding a solution, cadets learn to conduct risk assessments and assume the responsibility of strategic decision-making.
B) “Technical Barriers and Resource Scarcity Crisis” (Military Engineering and Tactical Support). Cadets are confronted with an unexpected logistical and engineering challenge where standard technical regulations prove ineffective.
Problem scenario (Conflict): “A battalion tactical group must cross a river. The main existing bridge has been destroyed by enemy aviation. Pontoon bridge equipment is at least 12 hours away. However, precise intelligence indicates that enemy artillery will begin shelling this area in 2 hours. The surrounding area contains only a local abandoned construction materials depot and forestry machinery.”
Heuristic approach and solution: Divided into groups, the cadets deconstruct the problem. They develop hypotheses for using available resources in non-standard ways: how to construct covert obstacles in a short timeframe using local materials, or whether it is possible to waterproof vehicles to cross via the riverbed. Physics, engineering, and hydrological calculations are conducted to establish the swiftest algorithm that minimizes casualties.

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Systemic conclusion: Problem-Based Learning elevates the serviceman from a mere “executing officer” who follows orders to a “strategist and problem-solver officer.” The actual battlefield never matches the ideal diagrams found in textbooks. Therefore, an officer who has learned to independently overcome cognitive dissonances in the classroom will not panic when facing real wartime crises and unexpected strategic threats, but will find asymmetric solutions instead.

4. Information-Communication and Digital Technologies.

Scientific foundation: These technologies are based on Richard Mayer’s “Cognitive Theory of Multimedia Learning” and George Siemens’ “Connectivism” educational paradigm. Mayer's works prove that when the human brain receives information through visual and auditory channels in parallel, the cognitive load decreases, and the coefficient of transferring information into long-term memory reaches its maximum. Gamification, on the other hand, relies on Mihaly Csikszentmihalyi's “Flow Theory” and dopamine-driven intrinsic motivation models. In military pedagogy, digital tools are not merely "visual aids" but cognitive platforms that transform scattered data into a single unified Situational Awareness.

Extended military-practical integration and digital tools:

A) Tactical Decision-Making Systems Based on Artificial Intelligence (AI) and Big Data: The modern officer must learn to operate within digital headquarters and intellectual analytical systems right in the classroom.

Practical process: Cadets conduct exercises using training models of modern C4ISR (Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance) systems. Neural networks (AI) analyze thousands of data points (Big Data) related to the enemy's equipment, radio frequencies, and movement trajectories in accordance with the training scenario.

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Tactical analysis: The cadet does not simply stare at a blank map; instead, they observe the percentage probabilities of potential enemy maneuvers modeled by artificial intelligence (e.g., "72% probability of enemy retreat or 28% probability of a flanking strike"). The cadet analyzes these digital forecasts to formulate their decision. This trains future staff officers in algorithmic and analytical thinking.

B) "Gamification' and VBS (Virtual Battlespace) Platforms in Military Education: Mechanically memorizing dry regulations and standing orders often leads to a decline in cadet motivation. Gamification addresses this issue through natural psychological interest.

Practical example: Higher military institutions utilize the professional tactical simulator software VBS (Virtual Battlespace). During the lesson, cadets sit before computers in groups or platoons linked via a network. They are assigned a specific mission on a digital map.

Motivational mechanism: Gaming elements—points, leaderboards, and difficulty tiers—are integrated into the process. The crew that executes the tactical maneuver correctly, conserves ammunition, and preserves personnel without casualties secures the highest score and becomes the leader on the board. According to Flow Theory, cadets become so immersed in the virtual competitive environment that they master standing orders and tactical principles seamlessly out of genuine interest, without even realizing it.

D) Digital Visualization and GIS (Geographic Information Systems) Engineering: Visualizing complex mathematical and physical laws in artillery, topography, and missile forces drastically enhances instructional efficiency.

Practical process: Alongside performing ballistic calculations on paper, cadets model them in specialized GIS (Geographic Information Systems) software.

Visual effect: The 3D relief of the terrain, atmospheric pressure, and wind speed are entered into the program. When the cadet inputs the coordinates they calculated, they observe the trajectory of the rocket or projectile and the point of impact (or deviation) on the screen in a dynamic graphic format. Seeing visually

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where a shell lands due to a single digit error fosters spatial awareness and technical responsibility in the cadet.

Systemic conclusion: Information-communication and digital technologies shift military education from a "static and passive" state to a "dynamic and interactive" one. An officer well-conditioned in a digital environment will not panic under the heavy information flows of modern network-centric warfare; instead, they will process data digitally within seconds to secure tactical dominance.

5. "Flipped Classroom" Technology.

Scientific foundation: The "Flipped Classroom' model is based on the inversion of B. Bloom's taxonomy, as well as Malcolm Knowles' principles of Andragogy (adult education) and Self-Directed Learning. In the traditional model, lower cognitive stages (remembering and understanding) were conducted in the auditorium with the instructor, while higher stages (applying and analyzing) were completed independently at home. In the "Flipped Classroom," this process is inverted: the cadet undertakes the passive cognitive load of receiving information individually outside of class hours, whereas the interactive classroom time is dedicated to the most challenging phases—synthesizing knowledge and solving practical problems.

Extended military-practical integration and analysis:

A) Time Management in Training Tactical Drone Operators and Intelligence Officers: This technology saves maximum resources in the military education system where instructional hours are exceptionally valuable.

Pre-class phase (Asynchronous learning): Via the military tactics system or LMS (Learning Management System) platform, cadets independently study the new topic—for example, "Types of UAVs (Unmanned Aerial Vehicles), their technical-tactical characteristics, and trajectories to bypass enemy air defense radars"—through video lectures, 3D animations, and digital field manuals.

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Before coming to class, they complete a basic quiz on the topic to verify their understanding.

Classroom phase (Synchronous learning): The instructor no longer wastes valuable classroom time dictating notes on standing regulations. The lesson immediately begins with a practical problem: "The map outlines enemy radar coordinates. Drawing upon the aerodynamic principles you studied at home, work in groups to plot the flight path for a strike drone to execute an undetected attack."

Pedagogical efficacy: The instructor acts not as a lecturer in class, but as a "Facilitator" (a moderator guiding the process) and a military consultant. This allows for an individual approach aligned with each cadet's level of comprehension and enables the real-time correction of errors.

Systemic Advantages of Introducing Modern Didactic Technologies into the Military Education Corps:

1. The Learner Becoming the Subject: The Foundation of "Auftragstaktik" (Mission Command).

Scientific essence: In traditional education, the cadet was an "object" (a mere recipient of orders and information). Modern technologies transform them into an active, managing "subject" of the process.

Military significance: This approach perfectly aligns with the most advanced command philosophy of modern armies—the principle of "Auftragstaktik" (Mission Command). Under this concept, higher headquarters does not issue rigid, mechanical orders to the officer; instead, it defines the overall objective and mission. The officer independently determines how to execute it based on the shifting realities of the battlefield. A cadet shaped as a subject in the classroom matures into a leader capable of seizing the initiative on the battlefield.

2. Shaping Metacognitive Independence: Preparation for Information Warfare.

Scientific essence: The cadet does not merely memorize information passively; instead, they cultivate proficiency in independent research, verification (fact-checking), and analytical filtering of data.

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Military significance: Under the conditions of modern hybrid and information warfare, misinformation, fake news, and psychological operations (PsyOps) deployed by the enemy are designed to mislead military personnel. An officer possessing independent analytical thinking skills can accurately assess the strategic and operational value of any information and arrive at the correct decision.

3. Activating Intrinsic Motivational Factors: Self-Determination Theory.

Scientific essence: According to research by Edward Deci and Richard Ryan, extrinsic motivation based on coercion is short-lived and fails to yield deep knowledge. Conversely, problem-based and gamified learning kindles intrinsic motivation (the gratification of achieving success and resolving problems).

Military significance: While military discipline relies on strict regulations, an officer's professional competence depends on continuous self-improvement. A cadet trained through digital simulators and case studies develops a genuine professional interest and a constant drive toward combat readiness, rather than a hollow sense of obligation toward military science.

4. Competency-Based Approach: Transitioning from Declarative Knowledge to Procedural Skill.

Scientific essence: Traditional education often halted at the "I know" (declarative knowledge) stage. Modern pedagogy, however, ensures the "I can apply" (procedural/functional competence) level.

Military significance: On the battlefield, dry theoretical knowledge is tested at the cost of human lives and casualties. A competency-based approach guarantees the cadet's capacity to translate acquired knowledge into functional action under stress, time constraints, and extreme conditions.

Modern pedagogical technologies in higher military educational institutions are not merely tools for modernizing instructional methodology; they represent a strategic factor determining national security and defense capability. In the asymmetric and network-centric warfare of the 21st century, victory is dictated

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not by physical weaponry alone, but by **"Cognitive Dominance"**—the capacity to think faster, analyze more accurately, and execute non-standard decisions quicker than the adversary.

The deep integration of interactive, problem-based, project-based, and simulation technologies into military pedagogy is the bedrock for supplying our army's ranks not with mechanical executors, but with a new generation of the officer corps possessing high intellectual capacity, ready for any unexpected geopolitical and combat crises. Transforming the educational system based on modern didactic innovations is the most effective and scientifically grounded path to radically enhancing the combat readiness of the armed forces.

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