INTEGRATED DIDACTIC DESIGN MODEL FOR ENGINEER OFFICERS' TRAINING: INSIGHTS FROM INTERNATIONAL EXPERIENCE

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The training of military engineering personnel is mainly carried out on the basis of military institutes, universities and academies. In addition to the specialty, military higher education institutions are aimed at instilling and developing strategic thinking, management and leadership qualities, which are the main requirements in the programs for training engineering officers. However, in the same process, they face a complex problem of integrating serious military skills training with academic education. This article analyzes existing research and international experiences and proposes an integrated joint program-didactically designed educational model aimed at bridging the persistent gap between the two training directions - specialty and military skills. The model includes pedagogical approaches, curriculum reform initiatives and the integration of new technologies such as computer-based learning environments. This work, based on the comprehensive and result-oriented application of didactic approaches in specialty programs, also synthesizes the best practices from international military education systems. The analysis highlights the importance of learning, knowledge transfer, and outcome-oriented training, especially in the context of the application of advanced military technologies, as well as the need for the practical application of scientific reasoning appropriate to complex security environments in the performance of challenging military tasks. The proposed model emphasizes a holistic approach to the development of engineer officer training, ensuring that academic knowledge, technology, and practical military skills reinforce each other, thereby increasing operational effectiveness and adaptability in modern war scenarios.

Key words: *Military education, engineer officer training, integrated didactic design model.*

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1. INTRODUCTION

Against the backdrop of conflicts occurring around the world, the impact of ever-developing technology is characterized by civil, military operations and hybrid threats. This requires that young officers being trained in higher military education systems not only have academic education and exceptional military skills, but also deep strategic thinking abilities, management and leadership qualities, as well as the preparation of military personnel with (Hornstra et al., 2023; Hornstra et al., 2024; Loishyn et al., 2024). Traditional military education systems, which are often divided into individual skills training and academic education paths in military specialties, which are often implemented in parallel, often have difficulty in achieving a comprehensive and successful integration of their components (Hornstra et al., 2023; Hornstra et al ., 2024). This creates difficulties in developing officers who can cope with the multifaceted problems of modern global security.

The article analyzes the current didactic designs in military education, using international experience and the latest pedagogical innovations, and explores the solution to this problem. The aim is to identify an integrated program model for training knowledgeable and skilled military engineer officers who can adapt to modern technology more quickly in order to effectively bridge the gap between practical military training and academic intellectual development.

2. METHODOLOGY

This study applied a mixed, qualitative and theoretical-analytical research design based on a systematic integrative review of international scientific literature, framework documents and institutional documents related to didactic design in military disciplines and higher military education. The main objective of the study is to explore various international experiences, conceptual models and pedagogical reforms in a consistent analytical approach that explains the possible application of didactic design for engineer training in modern military education systems. The data necessary for the analysis were collected during January 2026.

The analysis of scientific articles and academic literature was systematically obtained from resources indexed in authoritative databases such as "Web of Science" and "Scopus", and was supplemented with officially published NATO doctrines and policy documents in order to ensure both academic rigor and institutional credibility of the analytical framework. The search process was carried out using the keywords and phrases "military education", "engineer officer

training", "integrated didactic design model", "international experience" and "NATO Defense education enhancement program (DEEP)". The resulting primary data were refined, numerous articles were reviewed, and data from relevant sources were collected and analyzed. Rather than conducting empirical measurements, the study focused on conceptual clarification, comparative interpretation, and model synthesis, in line with existing approaches in professional military education (PME) research and instructional design. The analytical part consists of 25 peer-reviewed journal articles, conference proceedings, and official NATO policy documents published between 2013 and 2026, covering a sufficiently broad period to provide both historical depth and contemporary relevance.

The sources for the study were selected from the following areas: military academies and higher military education institutions, didactic design models, instructional systems design (ISD) and competency-based education, NATO-aligned educational frameworks and reform initiatives, digital and technology-enhanced military pedagogy (including multimedia, operational games, role-playing simulations and AI-enabled training systems), and ethical and value-based dimensions of military education (especially AI and autonomous systems). To ensure analytical rigor and transparency, the study applied specific inclusion and exclusion criteria. Inclusion criteria included a clear focus on military education or professional military education (PME), direct links to didactic design or pedagogical frameworks, discussion of international and NATO-aligned practices, and expert opinion or official institutional authorship.

Exclusion criteria included studies that were limited to civilian higher education and had little or no relevance to military education, purely technical manuals without pedagogical analysis, and opinion-based materials without methodological justification. The analytical procedure followed a four-step qualitative synthesis process: conceptual mapping, which identified the contribution of each source to didactic design; thematic coding, in which recurring concepts were grouped into categories such as integrated academic skills, competency-based design, and immersive technologies; comparative interpretation, in which thematic categories were compared across national and institutional contexts (particularly NATO member states, including the Turkish experience); and finally, model synthesis, in which an "integrated didactic design model" for military subjects was formulated, combining pedagogical tools, didactic mechanisms, and learning outcomes.

Methodologically, the study is based on three complementary frameworks: Instructional systems design (ISD), which provides a structural logic for curriculum development; Competency-based military education (CBME), which focuses on transferable competencies rather than content accumulation; and Technology-based pedagogy, which encompasses digital learning environments, AI-assisted instruction, and ethical governance.

To enhance analytical validity, the research was based only on peer-reviewed and institutionally authoritative sources. This approach, supported by transparent selection criteria and systematic thematic coding, provides a solid theoretical foundation for future empirical research and academic program, as well as educational program or training course experiments in military academies, and provides scientific justification for a didactic model that meets modern requirements for the training of engineer officers.

3. BACKGROUND AND CHALLENGES IN MILITARY DIDACTIC DESIGN

Historically, military education programs and training courses have focused on rigorous skills training, especially in combat, logistics, and operational procedures. In the basic and advanced stages of officer training, the program has aimed to simultaneously instill both academic - basic engineering education, and military management skills education - strategic thinking, leadership theory, and a broader geopolitical understanding (Hornstra et al., 2023; Hornstra et al., 2024; Loishyn et al., 2024; Dragomir, 2024). However, in many cases, the implementation of such parallel learning paths often occurs in an unintegrated manner, which creates a challenge that can hinder the development of a unified officer, creating inconsistencies and professional training. This challenge is particularly evident in military education programs where both directions are important but require greater integration.

A key need is that limited attention has been paid to didactic design of education as a specific mechanism for linking military training and academic education in the study of different models (Hornstra et al., 2023; Dragomir, 2024). If this challenge is addressed, the implications are significant given the increasing demand for officers with strategic thinking skills who can play roles at all levels in modern conflict zones, especially in complex operational environments. Furthermore, pedagogical paradigms for officer training have historically clashed, particularly in post-Soviet countries, where the shift from a "performer" mindset to a leadership-oriented approach is still ongoing, consistent with international best

practices (Loishyn et al., 2024). The ongoing military education reforms seek to align with the didactic principles of NATO countries, move away from Soviet-era traditions, and develop a leader-centered approach (Iskandarov & Gawliczek, 2019; North Atlantic Treaty Organization, 2025; NATO, 2013; Enstad & Hagen, 2026).

3.1. International experiences and pedagogical innovations

International military education systems are actively exploring innovative didactic approaches to integrate skills training and academic learning. As noted, military education reform efforts are strongly influenced by NATO best practices and focus on didactic principles that promote a holistic approach to personnel training (Mazurenko, 2024). These reforms involve adapting methodological systems to develop leadership qualities rather than just performance (Loishyn et al., 2024). The goal is to optimize education and training processes within NATO missions to enhance operational capabilities, as highlighted by analytical approaches that combine literature reviews and official document analysis [10]. The integrated didactic design model justifies a structured approach to training, while specifically addressing the need to bridge the gap between military skills training and academic education in military higher education institutions (Hornstra et al., 2024). The model that includes such an approach proposes a purposeful integrated development of curricula to ensure that military skills acquisition and academic learning are mutually reinforcing, rather than separate. According to Bodescu, A. (2024), horizontal and vertical integration of disciplines such as the Law of Armed Conflict (LOAC) is also important to ensure that non-legal practitioners, such as interns, master and apply these principles in real-life scenarios.

3.2. Integration of computer-oriented learning environments

The widespread application of technology, as evidenced by recent military operations and conflicts, and the acceleration of technological development have necessitated the integration of computer-oriented learning environments (COLE) into the curricula of military higher education institutions. Experience shows that COLEs, which are improved and didactically designed in accordance with military development, are designed to optimize pedagogical methods, at the same time increase the skill sets of the emerging officer corps and ensure the effectiveness of training by using information technologies (Rybchuk & Yaroshov, 2024). These environments provide various hybrid training - simulated, scenario-based training exercises on various topics and in any situation,

providing access to data analysis and distance professional development. Within the framework of didactic application, COLE technologies model the training module close to the real environment, forming an educational, motivating and effective training environment. The application of COLE technologies also achieves the desired didactic results in the military educational environment by modeling them close to real operational conditions.

Digital pedagogical tools, which were widely used during the COVID-19 pandemic, have been improved over time and adapted to military training systems. Multimedia technologies, task games, role-playing games and artificial intelligence-based learning assistance systems act as key components of this transformation. Specialized pedagogical tools that are already being applied in many training and education systems adapted from the experience of the COVID-19 pandemic are being rapidly developed.

3.3. Targeted didactic design model based on COLE technologies

Analyses show that (Table 1.) COLE technologies have various systematized didactic potentials in military education.

Table 1. Didactic potential of COLE technologies in military education.

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Source. Prepared by the author (based on various sources).

The didactic application possibilities of existing COLE technologies in international practice (Figure 1.) can be modeled as follows:

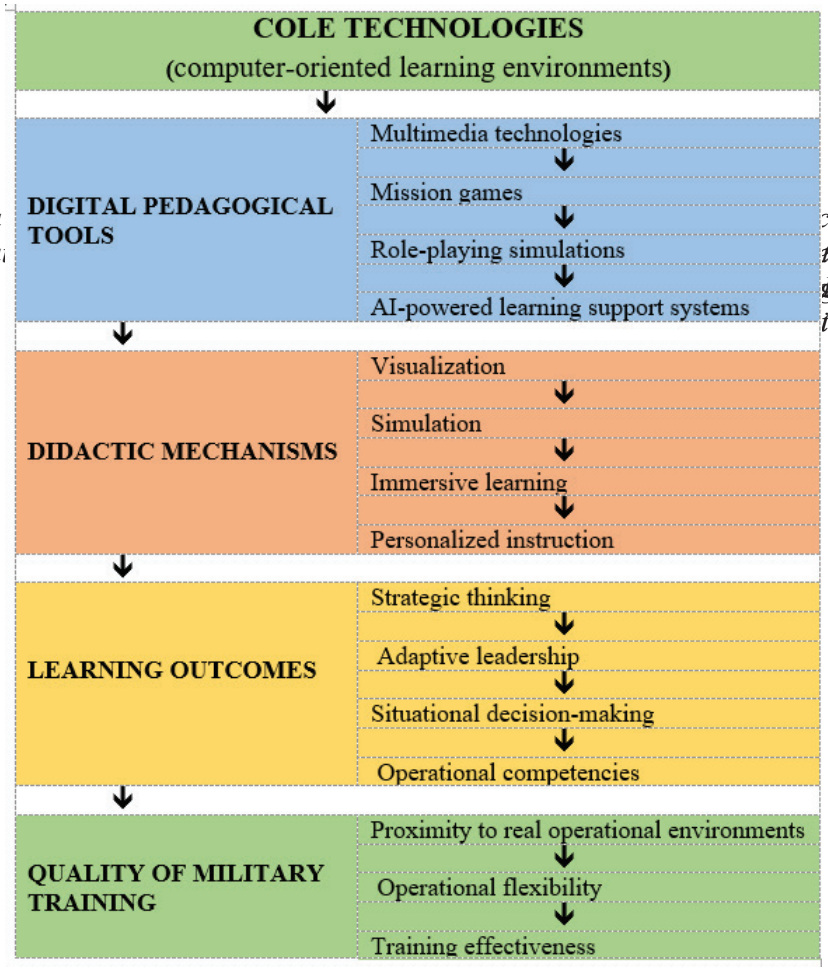

Fig. 1. Conceptual model of didactic design in military education based on COLE
Source. Prepared by the author

Note: The model illustrates the transformation of COLE technologies into digital pedagogical tools, which activate specific mechanisms leading to enhanced learning outcomes and improved quality of military training.

The proposed didactic model visualizes the complex relationships between curriculum design, technology integration, leadership training, and assessment mechanisms, as well as presents implementation stages and expected learning outcomes. This exemplary model aims to improve the current military engineering training experience and train personnel who meet the requirements of modern warfare.

The proposed didactic model consists of several key interrelated components:

Curriculum Design: Curriculum design is based on the methodologies of Instructional Systems Design (ISD) and Competency-Based Military Education (CBME). This approach involves a comparative analysis of previous military engineering training curricula with engineering disciplines and credit systems, as a result of which existing gaps and training needs are identified. The curriculum is focused on developing the knowledge, skills, and competencies necessary for soldiers' specific roles in the military. It includes modules based on practical work, laboratory exercises, and real-world problem solving.

Technology Integration: Technology integration involves enriching the learning process using technologies of the Custom Educational Environments (COLE). This integration includes multimedia technologies, mission games, role-playing games and artificial intelligence-based learning support systems. COLE technologies create immersive and interactive learning environments in the teaching-learning process, simulate military scenarios and offer personalized learning paths. This approach provides a transition from traditional teaching methods to digital pedagogical tools.

Leadership Training: Leadership training is central to military education. This component is aimed at developing critical thinking, decision-making, teamwork and ethical standards in future military leaders within the framework of CBME. Leadership training includes the practical application of theoretical knowledge, real-life leadership scenarios and teaching the principles of effective management in various military situations.

Assessment Mechanisms: Assessment mechanisms are closely related to the principles of CBME and provide a consistent and comprehensive measurement of the competencies of trainees. These mechanisms include both formative (to provide feedback throughout the training process) and summative (to

measure competencies at the end of training) assessment methods. Technology-based assessment enhances objectivity, tracks individual achievement, and allows for ongoing evaluation of program effectiveness.

The model's key relationships and structural flow relationships are based on the following principles:

ISD and CBME: Underpin curriculum design, leadership training, and assessment mechanisms. These approaches ensure that training is purposeful and results-oriented.

Technology-Curriculum Integration: COLE technologies are designed as an integral part of the curriculum, supporting the effective delivery of training content and the creation of interactive learning experiences.

Assessment Feedback: Assessment mechanisms continuously monitor the effectiveness of the curriculum, technology integration, and leadership training and provide feedback for adjustments as needed.

Note: The structural flow of the model reflects a continuous cycle, starting from the analysis of training needs, to the design of an appropriate curriculum, the integration of technologies, the implementation of training, and finally the evaluation of results.

As for the implementation stages, the implementation stages of the proposed didactic model are structured in accordance with the ISD principles:

Analysis: A comprehensive analysis of training needs, target audience characteristics, and existing constraints. This also includes identifying gaps in the military engineer training curriculum.

Design: Preparation of training objectives, teaching methods, assessment strategies, and a plan for integrating COLE technologies into the curriculum.

Development: Creation or adaptation of teaching materials, digital resources based on COLE technologies, and assessment tools.

Implementation: Implementation of the developed curriculum and training programs in military educational institutions.

Evaluation: Continuous assessment of the effectiveness of the training program, student achievements, and the overall success of the model, and collection of data for future improvements.

The expected educational outcomes from the implementation of this model are to increase the ability of military personnel to effectively respond to modern challenges.

The main outcomes include:

Higher military competencies: Deepening of knowledge and skills in the field of military engineering.

Critical thinking and problem solving skills: Strengthening the

ability to think analytically and find effective solutions in complex military scenarios.

Effective decision making: Development of the ability to make sound and timely decisions in stressful situations.

Adaptation and flexibility: Rapid adaptation to the changing military environment and technological innovations.

Adherence to military ethical norms: Full compliance with professional ethics and military discipline standards.

These educational outcomes will contribute to both the development of individual military personnel and the effectiveness of the army as a whole.

3.4. Conceptual diagram description

The diagram below (Figure 2.) visually presents the main components of the proposed didactic model, their interrelationships, methodological foundations, application stages, and expected educational outcomes.

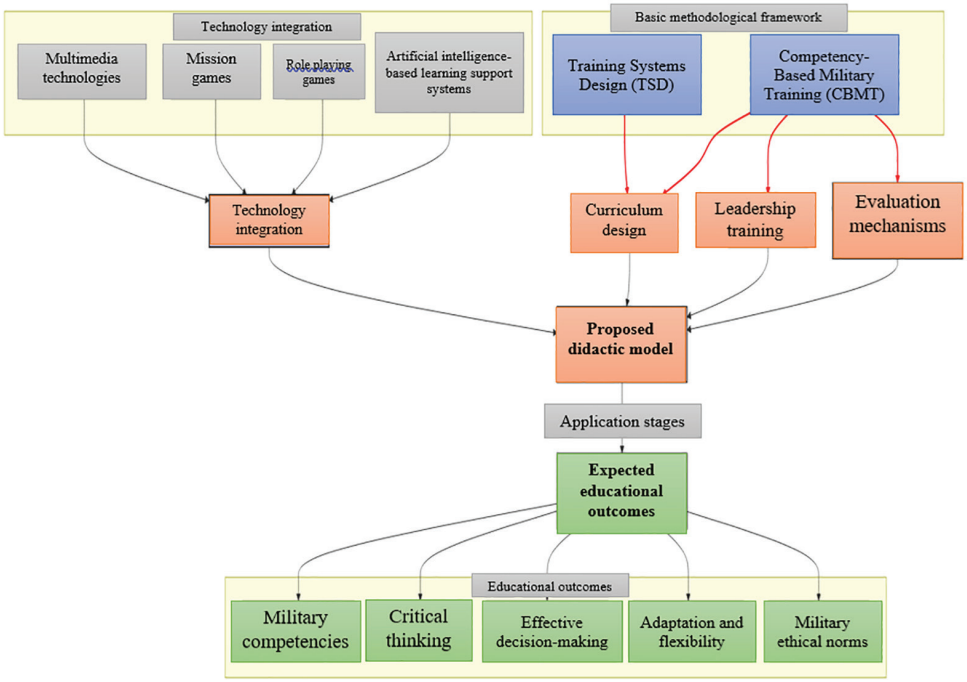

Fig. 2. Conceptual diagram of the relationships between the main components of the proposed didactic model
Source. Prepared by the author

In the diagram:

• The core methodological framework (Instructional Systems Design (ISD) and Competency-Based Military Education (CBME)) represents the fundamental principles of the model.

• Curriculum design, Technology integration, Leadership training and Assessment mechanisms are the main pillars of the model and flow in an interconnected manner into the center of the proposed didactic model.

• Within the technology integration block, specific types of COLE technologies (Multimedia, Mission Games, Role Playing, Artificial Intelligence-Based Training Support) are detailed.

• The implementation process of the model progresses towards the Expected Learning Outcomes through the Implementation Stages axis.

• The expected learning outcomes, in turn, include the defined military competencies and skills.

3.5. Ethical considerations and Aİ integration

Research has shown that the availability of new technologies, particularly the ethical implications of Artificial Intelligence (AI), is central to military didactic design (Azafrani & Gupta, 2023; Taddeo et al., 2024). Integrating responsible AI principles and practices into defense institutions requires specific ethical guidelines for the development and deployment of AI systems in military contexts. This requires new pedagogical approaches to address complex issues such as algorithmic bias, autonomous weapon systems, and the inhumane aspects of modern warfare. A values-based approach that incorporates the views of large stakeholder groups is used for the design of military autonomous systems (Boshuijzen-van Burken et al., 2024). Similarly, the Law of Armed Conflict (LOAC) requires an integrated curriculum approach to ensure that trainees, including non-lawyers, effectively understand and apply LOAC principles in real-world operational scenarios. This necessitates didactic strategies that go beyond mere legal instruction and move toward practical correlation with real-world situations (Bodescu, 2024).

4. DEVELOPMENT OF DIDACTIC PRINCIPLES AND PROFESSIONAL DEVELOPMENT

The theoretical foundations of didactic principles in military education stem from broader concepts within general subject didactics and focus on content-based teaching and learning in specific academic fields (Dadaşov, 2024; Ruslan & Andrii, 2024). This framework guides efforts to improve the didactic design of engineering education for both faculty and students in military institutions. The development of

didactic principles-based design among faculty and students in higher military education institutions is also essential, and the structure and features of a well-defined curriculum for effective instruction enhance the capabilities of didactic design, as well as the overall quality and future effectiveness of instruction (Dadaşov, 2024).

The evolution of instructional system development (ISD) models, such as those in the US Air Force, demonstrates a continued commitment to improving pedagogical approaches in military training and underscores the long-standing emphasis on systematic instructional design procedures (Yang et al., 2024). Modern management approaches are also applied to the management of the activities of military pedagogical personnel, focusing on optimal methods for employees in dynamically changing security environments (Meyer et al., 2024).

5. PEDAGOGICAL EVALUATION AND TRANSFER OF TRAINING

A comprehensive review of international practices and pedagogical innovations highlights a clear and compelling need for integrated instructional design in military education. The traditional separation of skills training and academic education is increasingly inadequate to prepare officers to deal with the complexities of modern warfare (Hornstra et al., 2023; Hornstra et al., 2024). Evidence from various military academies and educational reforms suggests that successful integration requires a multidisciplinary approach. It is essential to adopt curricula that clearly align learning objectives across both practical and academic modules (Hornstra et al., 2024).

This includes not only vertical integration, which ensures the progressive development of knowledge and skills over time, but also horizontal integration, which fosters interdisciplinary connections that reflect the multidisciplinary nature of modern military operations (Bodescu, 2024). For example, integrating the principles of the Law of Armed Conflict (LOAC) into various operational courses, rather than treating them as isolated legal topics, allows trainees to relate these principles to real-world situations, thereby improving their applicability in the field (Bodescu, 2024).

Technological advances offer significant opportunities for improving instructional design. Computer-based learning environments (COLEs), multimedia tools, task games, and role-playing simulations provide immersive and efficient methods for applying practical skills and developing strategic thinking (Rybchuk & Yaroshov, 2024; Truong et al.,

2024; Karadimas, 2025; Horiacheva & Ryzhykov, 2024). These tools, especially task games, can significantly reduce the risks and costs associated with traditional training while fostering collaboration and strategic thinking (Karadimas, 2025). The emerging use of AI-powered learning assistance systems promises to enable personalized learning and effective learning, adapt to individual learning paces, and provide immediate feedback (Chamnankij et al., 2025).

However, the integration of advanced technologies, especially AI, requires a strong focus on ethical considerations (Azafrani & Gupta, 2023; Taddeo et al., 2024). Military instructional design must proactively address the ethical implications of autonomous systems, algorithmic bias, and the impact of technology on human rights (Taddeo et al., 2024; Boshuijzen-van Burken et al., 2024). The inclusion of discussions, case studies, and simulations focused on responsible AI development and deployment is essential for developing ethically informed leaders. The role of educators is central to this integrated approach. Continuous professional development for military educators is essential, focusing on modern didactic principles, the use of effective technologies, and interdisciplinary teaching strategies (Dadaşov, 2024; Ruslan & Andrii, 2024). The development of a strong "didactic culture" characterized by structured and effective teaching informed by systems-based instructional development (SSD) models is essential for improving teaching quality and ensuring pedagogical relevance (Ozogul 2023).

Finally, robust assessment and feedback mechanisms must be implemented to validate the effectiveness of these integrated models (Meyer et al., 2024). It is important to assess not only knowledge acquisition, but also the transfer of learning into practical application and the development of leadership skills. Feedback from operational commanders and trainees can provide invaluable insights for improving didactic approaches and reinforces the importance of a continuous development cycle (Hornstra et al., 2024). Intention-based leadership can also be incorporated into feedback loops to further enhance leadership development by empowering subordinates and encouraging independent decision-making (Dragomir, 2024).

6. DISCUSSION: TOWARDS AN INTEGRATED INSTRUCTIONAL DESIGN MODEL

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7. CONCLUSIONS

Didactic design in military disciplines is undergoing a transformation due to the complexity of modern warfare and rapid technological advances. International experiences reveal a shared commitment to move beyond traditional, isolated educational approaches towards integrated models that seamlessly integrate military skills training with academic education. By prioritizing didactic instructional design as a critical foundation, embracing computer-based learning, integrating ethical frameworks for emerging technologies such as artificial intelligence, and utilizing innovative pedagogical tools, military academies can produce engineering officers who are not only technically proficient but also strategically intelligent, ethically grounded, and adaptable leaders. This integrated approach to didactic design is essential for enhancing the operational capabilities of armed forces and ensuring their effectiveness in an ever-evolving global security landscape. Future research should focus on regular empirical studies to study and enrich the pedagogical impacts of emerging technologies such as academically integrable, advanced, digital, and artificial intelligence, to validate the effectiveness of these integrated models in various military contexts.

DATA AVAILABILITY STATEMENT

Note for the data availability statement.

"All data are included in the manuscript.".

AI DISCLOSURE

The author acknowledge the use of the following generative AI tools to assist in the preparation of this manuscript: ChatGPT. This tool was used solely for language editing and structural suggestions, under the complete control and responsibility of the authors. All AI-assisted content was critically reviewed and revised by the authors, who accept full responsibility for the accuracy and integrity of the final version.

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