

Multi-Vector Approaches to Building Professional Competence of Future Reserve Officers in the Higher Education System

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Received: November 14, 2025

Accepted: August 16, 2026

Online Published: August 19, 2026

doi:10.11114/jets.v14i4.8181

URL: <https://doi.org/10.11114/jets.v14i4.8181>

Abstract

Contemporary geopolitical dynamics and the prevalence of hybrid threats underscore the critical need for innovative training methodologies for reserve officers. This study addresses the imperative to optimize training within higher education systems by developing professional competence through a multi-vector pedagogical approach that synchronizes cognitive, operational, and value-motivational domains. A mixed-methods research design was implemented, employing a convergent parallel design to integrate quantitative performance metrics with qualitative narrative protocols. The study involved 120 cadets, comparing an experimental group utilizing synchronized simulations and project-based learning with a control group following traditional curricula. The findings reveal that this multi-vector approach fostered a holistic increase in professional competence, particularly in technical proficiency and complex decision-making. Qualitative analysis of think-aloud protocols illustrated a transformative shift from fragmented theoretical knowledge to integrated operational fluency. Furthermore, the intervention significantly strengthened intrinsic motivation, demonstrating that the internalization of professional values is a key driver of competence growth. The results suggest that military departments should move toward holistic instructional architectures that simultaneously engage intellectual and affective dimensions. This model offers a scalable strategy for enhancing officer resilience and professional identity within the condensed timelines characteristic of reserve officer training programs.

Keywords: professional competence, military education, self-efficacy, synergistic effect, leadership qualities, innovative methods

1. Introduction

The system of military personnel training is gaining special importance in view of dynamic changes in the geopolitical landscape accompanied by the emergence of new challenges and forms of warfare. The paradigm shift from traditional to modern requires the preparation of future reserve officers not only with deep theoretical knowledge, but also with comprehensive professional competence. It should include leadership, practical, and value components (McClung et al., 2023; Ishchenko et al., 2022; Chadler et al., 2024). Existing traditional training methods do not always provide an adequate response to this requirement. They are mostly focused on the transfer of static information, rather than the development of dynamic skills (Lennox et al., 2021). This circumstance creates an urgent need to develop and implement innovative educational strategies that meet current needs.

It should be noted that the need to optimize military training is not unique to Ukraine, but corresponds to a global trend, especially among NATO member states. The armed forces of the United States and leading EU states, faced with the challenges of hybrid conflicts, have also made a systematic transition to competency-based approaches to training reserve officers. These approaches emphasize the practical integration of knowledge, the use of high-precision simulations, and the development of sustainable leadership qualities, which is critically important in a dynamic operational environment (Huluba, 2021). Thus, the proposed multi-vector approach is consistent with international best practices.

The research problem is to resolve the contradiction between the growing requirements for the professional competence of officers and the limited opportunities for their training in civilian higher education institutions (HEIs). Existing limitations include short training periods, the lack of a permanent military environment, and the specifics of the civilian audience (Semenenko et al., 2023). Research in this area is critically important for the development of military pedagogy, as it contributes to the formation of competent specialists who are able to effectively perform tasks in modern conditions. Existing studies focus on individual aspects of training (Jagatheesaperumal et al., 2024). These include the use of problem-based learning or training character strength, but they lack a comprehensive approach that would combine disparate elements.

This study proposes a *Multi-Vector Pedagogical Approach (MVPA)* as a structured educational model designed to holistically develop the professional competence of future reserve officers. The approach is termed 'multi-vector' to emphasize the simultaneous and integrated development along three distinct but interconnected vectors, moving beyond fragmented methods (MacAvaney et al., 2025):

1. *The Cognitive Vector*: focuses on the acquisition and deep understanding of theoretical knowledge, analytical skills, and procedural frameworks foundational to military science.
2. *The Operational Vector*: aims at developing practical skills, decision-making abilities, and procedural fluency through simulated scenarios, hands-on exercises, and project-based tasks that mirror real-world complexity.
3. *The Value-Motivational Vector*: is dedicated to fostering leadership identity, ethical judgment, psychological resilience, and intrinsic motivation for professional service and continuous self-development.

The hypothesized mechanism of MVPA is synergistic integration (Ishchenko et al., 2023). The vectors are not merely additive; they interact dynamically to produce a compounded effect on competence development. For instance, theoretical knowledge (Cognitive) is reinforced and contextualized by practical application (Operational), while the challenges and ethical dilemmas encountered in practice stimulate the development of professional values and sustained motivation (Value-Motivational). This model differs from established competency-based frameworks, which often prioritize the discrete assessment of skills, by emphasizing the continuous and purposeful interplay of knowledge, practice, and values within a unified pedagogical process. The MVPA is thus positioned as a comprehensive response to the fragmented nature of traditional training.

This study solves the above problem (the lack of a comprehensive approach) by substantiating and empirically testing the effectiveness of multi-vector pedagogical approaches. They are considered as a synthesis of different educational paradigms, which ensures flexibility and adaptability of the educational process. The research aims to create an academically grounded model that will meet modern requirements and contribute to the optimization of reserve officer training.

The focus of the research is to study the influence of multi-vector approaches on the development of professional competence of future reserve officers. It also reveals the relationships between these approaches and the level of motivation for professional self-development. The academic novelty of the study is the experimental testing of a multi-vector approach to the development of professional competence of future reserve officers. It combines cognitive, practical, and value components into a single educational strategy. Such a model differs from existing ones as it provides a holistic vision of the process, rather than considering its individual elements. This circumstance makes it possible to fill the gap in theoretical and empirical research on military pedagogy.

The aim of the research was to substantiate the effectiveness of multi-vector pedagogical approaches to the development of professional competence of future reserve officers in HEIs. *Research objectives*:

1. Analyse existing theoretical models of the development of professional competence of reserve officers.
2. Identify and test a multi-vector approach to training in the higher education system.
3. Empirically verify the impact of the above-mentioned approaches on the level of students' professional competence.

2. Literature Review

2.1 Competency-Based Paradigms in Military Education

The definition of an officer's professional competence has evolved beyond static knowledge to encompass integrated cognitive, practical, and ethical dimensions capable of responding to hybrid threats (McClung et al., 2023). This shift is reflected in NATO and US military educational programs, which have transitioned towards competency-based training models emphasizing adaptability and applied skills (Huluba, 2021). Central to this transition is the adoption of simulation-based training (SBT) and scenario planning, which serve as the primary vehicles for developing decision-making proficiency in complex, non-linear environments.

Traditional pedagogical methods, often focused on knowledge transfer, are recognized as insufficient for developing the dynamic leadership and resilience required in modern operational environments (Lennox et al., 2021). Consequently, contemporary research explores experiential learning methodologies to build this holistic competence, such as problem-based learning to enhance knowledge application (Chueh & Kao, 2024) and character strength training to fortify the ethical foundations of leadership development (Déri et al., 2025). The training of reserve officers within civilian Higher Education Institutions (HEIs) presents unique challenges, including condensed timelines and the absence of a permanent military environment, further necessitating optimized, integrated approaches (Semenenko et al., 2023). In such contexts, a multi-vector approach acts as an operational bridge, ensuring that theoretical knowledge is immediately synthesized with practical skill acquisition through realistic simulation cycles.

2.2 Active and Simulation-Based Methodologies

A key response to the need for dynamic skill development is the adoption of active, experiential learning strategies. Simulation-based training, scenario planning, and project-based learning create immersive environments where theoretical knowledge is operationalized. Such methods are crucial for developing procedural fluency, situational judgment, and technical skills under realistic constraints. The integration of advanced technologies like extended reality (XR) and the metaverse offers new potentials for creating high-fidelity, scalable training simulations (Jagatheesaperumal et al., 2024). Similarly, generative artificial intelligence (AI) presents opportunities for personalized scenario generation and adaptive learning, though its practical application in military pedagogy requires careful study (Kurtz et al., 2024). These tools align with the broader framework of competency-based education, which structures curriculum and assessment around the integrated application of knowledge, skills, and attitudes (Marcotte & Gruppen, 2022). Adjacent research also underscores the importance of physical readiness, achieved through military-applied sports, as a foundational component of overall operational capacity (Tychyna et al., 2024).

2.3 Developing Leadership and Value Systems

Professional military competence is inseparable from leadership qualities and a robust value system. Values function as core motives that directly influence professional behavior and decision-making, especially under duress (Pincus, 2024). The cultivation of character strength and academic integrity is therefore not an ancillary concern but a central pillar of vocational military training (Déri et al., 2025). Research in adjacent fields, such as sports psychology, confirms that intrinsic motivation and the drive for self-realization are critical for overcoming challenges and achieving high performance (Krasnik et al., 2024), a concept directly transferable to the military context. The development of these internal, value-driven factors requires pedagogical attention alongside cognitive and operational training.

2.4 Conceptualizing the "Multi-Vector" Approach in Pedagogy

The "multi-vector" terminology is adopted in this study to describe an educational strategy characterized by the simultaneous and adaptive engagement of multiple instructional dimensions. While the term has roots in multidimensional systems analysis to describe non-linear processes, its pedagogical application here signifies a move toward holistic competence development. This conceptualization builds upon recent research exploring multi-vector approaches to enhance collaborative skills and psychological readiness in modern education (Turemuratova et al., 2024; Turemuratova & Yoldasheva, 2025).

Within this framework, the multi-vector pedagogical approach is defined as the intentional and synergistic integration of three primary vectors: the cognitive vector focusing on theoretical internalization, the operational vector targeting practical proficiency in high-stakes simulations, and the value-motivational vector stabilizing professional identity (Turemuratova, Masharipova & Atabayeva, 2025).

The core mechanism of this approach lies in the simultaneity and non-linearity of its impact. Unlike competency-based frameworks, which often prioritize the sequential accumulation of discrete skills (the "what"), or integrative learning, which focuses on the simple connection between theory and practice, the multi-vector approach operationalizes the "how" of professional resilience. It hypothesized that when cognitive knowledge is applied within the operational vector while simultaneously being reinforced by the value-motivational vector, a synergistic effect is achieved. This synergy

prevents the fragmentation of skills and ensures that theoretical knowledge is immediately converted into operational fluency.

Consequently, the multi-vector approach differs from established models by its focus on dynamic interaction rather than additive components. It provides a concrete basis for synthesizing discrete methodologies into a coherent training model that reflects the complex, multi-directional demands of modern military service, where theoretical understanding, practical action, and psychological stability must be deployed as a single, unified response.

2.5 Identified Research Gaps

Despite advancements, significant gaps persist. There is a lack of empirical data on the long-term efficacy and career impact of integrated pedagogical models like the proposed MVPA. The methods for effectively incorporating emerging technologies (e.g., AI, XR) into military curricula require further study. Furthermore, research on developing leadership and psychological resilience within the context of rapidly evolving hybrid threats remains insufficient. The mechanisms for adapting such integrated approaches to different cultural and institutional contexts within global military education also warrant deeper investigation.

2.6 Conceptual Framework and Hypotheses

The synthesis of the reviewed literature suggests that while the components of professional competence (cognitive, operational, and value-motivational) are well-recognized, their simultaneous development through a multi-vector approach remains under-researched in the context of reserve officer training. The existing evidence indicates a shift toward experiential and project-based learning, yet a gap exists in understanding how these vectors interact synergistically under a unified pedagogical framework.

Drawing upon the principles of the multi-vector pedagogical approach and the need for a holistic training model that integrates theoretical knowledge with high-stakes decision-making and intrinsic leadership values, the following hypotheses have been formulated:

- Hypothesis 1 (H1): The implementation of a multi-vector pedagogical approach leads to a significantly higher level of overall professional competence in future reserve officers compared to traditional, lecture-based instructional methods.
- Hypothesis 2 (H2): The multi-vector pedagogical approach produces the most substantial gains in the operational-activity vector, specifically enhancing technical proficiency and decision-making capabilities in simulated operational environments.
- Hypothesis 3 (H3): There is a significant positive correlation between the strengthening of the value-motivational vector (intrinsic motivation and professional identity) and the overall growth of professional competence among cadets.

3. Method

3.1 Research Design

A quasi-experimental design was used. Its choice was determined by the need to empirically test the effectiveness of pedagogical intervention in conditions where complete randomization of the sample is impossible. The study is mixed in terms of time scale. It combines elements of both longitudinal and cross-sectional designs. The duration of the study is September 2024-August 2025 of the academic year. The design included three consecutive stages, which are presented in Figure 1.

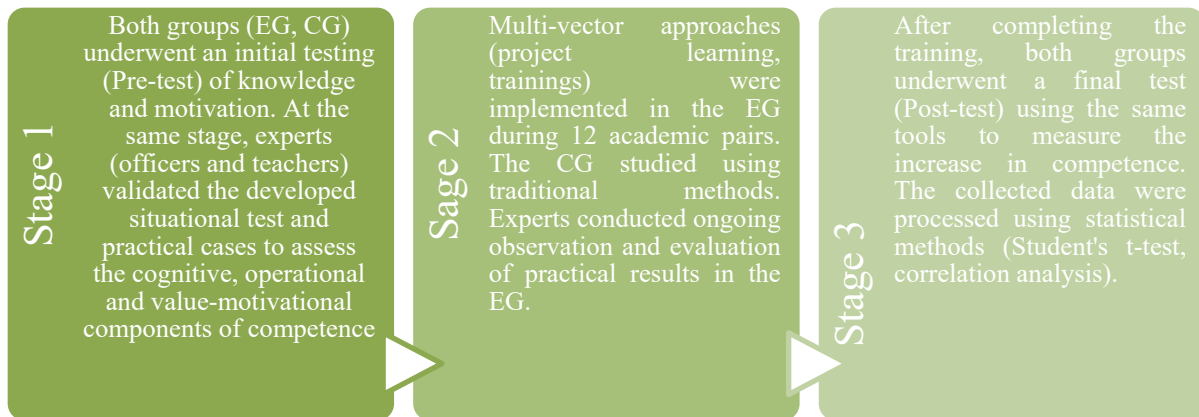


Figure 1. Structural Model of the Multi-Vector Pedagogical Approach for Training Reserve Officers

Note. EG = experimental group; CG = control group. The diagram illustrates the interaction between officers and teachers within the cognitive, operational, and value-motivational vectors.

Source: developed by the authors

The chosen design complemented by qualitative methods provided a comprehensive view. It provided both a quantitative assessment of the effect and a deep understanding of the mechanisms of influence. Therefore, it became possible to substantiate the advanced hypotheses.

3.2 Participant Selection and Group Allocation

The study was conducted at three Ukrainian higher education institutions with established programs for training reserve officers. A stratified multi-stage selection procedure was employed to ensure the representativeness of the sample across different regions. First, three higher education institutions were purposively selected. Second, within these institutions, relevant faculties running reserve officer programs were identified. Third, from these faculties, intact academic groups of third and fourth-year students were systematically selected based on their enrollment status. All students in the selected groups were invited to participate, resulting in a final sample of 120 male cadets aged 20-25. Individuals with active military service status, a previously held officer rank, or relevant medical or psychological limitations were excluded prior to the study.

Due to the logistical and ethical constraints of working within an established educational structure, individual randomization of participants was not feasible. Consequently, a quasi-experimental design was implemented using a non-randomized allocation of intact academic groups. To minimize selection bias and ensure baseline comparability, groups from the same institution and academic specialty were paired; within each pair, one intact group was assigned to the experimental group and the other to the control group. This approach maintained a naturalistic educational setting while establishing baseline equivalence through systematic group matching and pre-testing.

Traditional training in the control group was conducted through a linear instructor-led curriculum primarily consisting of theoretical lectures and standardized seminars focused on rote memorization of military regulations. In contrast, the experimental group followed a multi-vector pedagogical approach where the same thematic content was restructured into ninety-minute sessions integrating interactive briefings, high-fidelity simulations, and reflective debriefings. While the control group relied on knowledge-based testing of theoretical recall, the experimental intervention modified these activities into project-based tasks that required cadets to adapt to changing variables and apply integrated operational skills in real-time scenarios.

Several steps were taken to mitigate selection bias and enhance group comparability. Groups were matched based on key institutional and academic variables such as the specific higher education institution, year of study, and specialty. Comprehensive pre-testing was conducted using the Professional Competence Test and the Motivation for Professional Self-Development Questionnaire. As reported in Section 4.1, independent samples t-tests confirmed no statistically significant differences between the experimental group and the control group on these key outcome measures at the outset of the study. In subsequent analyses, Analysis of Covariance was used where appropriate to control for any remaining minor pre-test differences.

The non-random allocation of intact groups is acknowledged as a limitation. While baseline equivalence on measured outcomes was established, other unmeasured confounding variables may exist. Plausible confounds inherent to this design include instructor effects, where different instructors despite using standardized protocols could introduce variance based on teaching style. Pre-existing social dynamics and group cohesion within the intact cohorts could also

differentially influence engagement. Furthermore, the intervention was conducted under martial law in Ukraine, and while affecting all participants, specific stress levels or external distractions could have varied non-systematically between groups. These confounds are typical in field-based educational research, and the design sought to minimize their impact through careful group pairing and statistical verification. An a priori power analysis was conducted using G*Power software for a repeated-measures ANOVA. With an assumed medium effect size, alpha of .05, and power of .80, the analysis indicated a minimum required sample size of 106 participants. The sample was increased to 120, with 60 participants per group, to account for potential attrition and ensure robust analytical power.

Due to the structural requirements of the military educational environment and the necessity of maintaining unit cohesion, a non-random, convenience sampling approach was utilized for group allocation. Participants were assigned to either the experimental or control group based on their established cadet platoons. To mitigate potential selection bias, baseline equivalence testing was conducted using pre-intervention scores for professional knowledge and motivation, which showed no statistically significant differences between the groups ($p > .05$). While the non-random nature of this allocation is acknowledged as a limitation, plausible confounds such as prior academic standing and instructor variance were controlled by ensuring both groups originated from the same cohort and followed an identical core syllabus.

3.3 Data Collection

1. The assessment of professional competence was conducted through a multi-dimensional toolkit designed to capture both quantitative metrics and qualitative insights. The primary quantitative instrument was the Professional Competence Test (PCT), developed to evaluate the core outcomes of the multi-vector approach. The PCT was structured into four content domains: (1) Tactical-Technical Proficiency (15 items), (2) Strategic Decision-Making (10 items), (3) Military Management and Leadership (10 items), and (4) Ethical-Legal Frameworks (5 items). The instrument comprised forty items, including thirty multiple-choice questions for theoretical knowledge and ten situational judgment tasks simulating real-world decision-making. The theoretical section was scored objectively, while the practical tasks required cadets to prioritize actions under time-constrained hybrid threat conditions, evaluated using a standardized analytical rubric. To ensure content validity, the test underwent a formal review by a panel of five senior military instructors, resulting in a Content Validity Index (CVI) of .92. Reliability was established through a Cronbach's alpha of .84 for the theoretical domain and an Intraclass Correlation Coefficient (ICC) of .88 for the practical domain, indicating high scoring consistency.

2. Motivation for professional development was measured using an adapted version of the Work Extrinsic and Intrinsic Motivation Scale (WEIMS). The adaptation process involved modifying the original eighteen items to specifically reference military training, tactical simulations, and reserve officer duties instead of generic corporate contexts. This scale assessed three subscales—*intrinsic motivation*, *identified regulation*, and *external regulation*—which were selected to directly operationalize the value-motivational vector of the proposed pedagogical model. Specifically, these subscales allowed for testing the hypothesis that the multi-vector approach facilitates a transition from compliance-based external regulation to autonomous identified regulation, essential for professional resilience. For this specific cadet sample, the internal consistency (Cronbach's alpha) ranged from .79 to .86, indicating robust reliability. Content validity was confirmed by three military pedagogy experts who ensured the items specifically targeted the professional self-development goals and the internalization of military values (Turemuratova et al., 2025).

3. In accordance with the convergent parallel design, these quantitative measures were supplemented by expert assessments and narrative protocols. A group of experienced military personnel utilized structured checklists to evaluate the cognitive, operational, and value-motivational components of cadet performance. This qualitative strand included the use of think-aloud protocols, where cadets verbalized their reasoning during complex simulations. This allowed for the triangulation of data, ensuring that the statistical growth observed in the experimental group was cross-validated by the shift from fragmented knowledge to integrated operational fluency.

3.4 Analysis of Data

At the first stage of the study, descriptive statistics were used: arithmetic mean (M), standard deviation (SD), median (Me) and interquartile range (IQR). Before comparative analysis, normality of distribution was checked by the Shapiro-Wilk test and homogeneity of variances by Levene's test. The groups were compared at the beginning of the experiment by using Student's t-test for independent samples. The dynamics of changes within groups was assessed using the t-test for dependent samples. The effectiveness of the intervention was checked by analysis of variance (ANOVA) with repeated measures. Analysis of covariance (ANCOVA) was used to take into account initial differences. The relationship between motivation and effectiveness was investigated by Pearson's correlation analysis and linear regression. The practical significance of the results was assessed through the effect size (Cohen's d and η_p^2). Qualitative data from expert evaluation were subject to content analysis. The level of statistical significance was set at $p < .05$.

3.5 Instruments

Data processing included a set of statistical methods. The R software environment and IBM SPSS Statistics 27 were used. R implemented graphing, normality testing, and effect calculations, which allowed for visualization of key results. SPSS performed t-tests, variance analysis, and regression analysis with multicollinearity control, which ensured the reliability of statistical conclusions.

4. Results

4.1 Preliminary Analysis and Descriptive Statistics

Preliminary analysis confirmed the equivalence and homogeneity of the CG and EG at the beginning of the study. The Shapiro-Wilk test confirmed the normality of the distribution for professional competence ($W = .98, p = .12$) and motivation ($W = .97, p = .08$). Levene's test confirmed the homogeneity of variances ($p > .05$). Initial comparisons between groups did not reveal significant differences in the level of professional competence ($t(118) = .52, p = .605, d = 0.10$) or motivation ($t(118) = .71, p = .478, d = .13$). The obtained data are presented in Table 1.

Table 1. Descriptive statistics and intragroup comparisons ($M \pm SD$)

Variable	Group	Pre-test	Post-test	t-test	p-value	Cohen's d
Professional competence	CG (n=60)	68.3 $\pm$ 8.1	71.2 $\pm$ 7.8	$t(59) = 2.15$	0.036	0.36
	EG (n=60)	69.1 $\pm$ 7.9	84.6 $\pm$ 6.3	$t(59) = 12.87$	<0.001	2.18
Motivation	CG (n=60)	72.5 $\pm$ 6.9	73.1 $\pm$ 7.2	$t(59) = 0.61$	0.542	0.09
	EG (n=60)	73.4 $\pm$ 6.5	81.9 $\pm$ 5.8	$t(59) = 8.24$	<0.001	1.38

Source: developed by the authors based on research results

Preliminary analysis confirmed the equivalence of the CG and EG at the beginning of the study, which allows for a correct comparison of their results. In the CG, only minor changes in professional competence and motivation were observed, the effects of which were weak. In the EG, statistically significant improvements were recorded with very large effects, which indicates a high effectiveness of the intervention. The obtained data indicate a pronounced relationship between participation in the training and the growth of professional competence and motivation. At the same time, the lack of randomization requires caution in causal conclusions.

4.2 Testing the Effect of the Intervention (Hypothesis H1)

A graphical representation of the results of the dynamics of professional competence is given in Figure 2. The visualization reflects the changes in indicators in the CG and EG at two stages of the study. The illustration demonstrates the effect of pedagogical intervention during the training period.

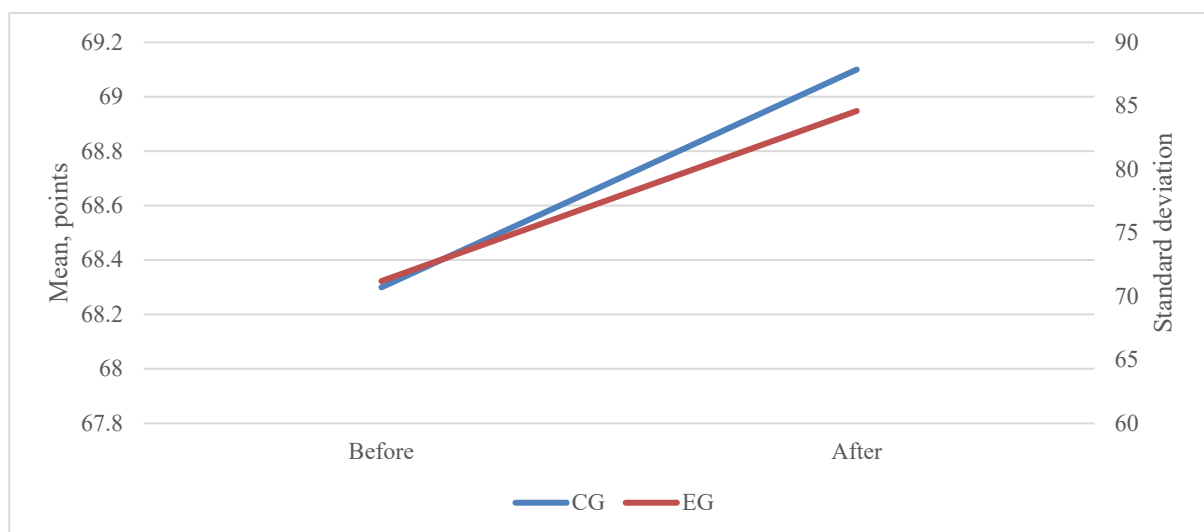


Figure 2. Dynamics of professional competence of CG and EG

Source: developed by the authors based on research results

The figure illustrates the divergent trajectories of professional competence development from the pre-test to the post-test stage. The control group shows a marginal improvement consistent with traditional instructional methods. In

contrast, the experimental group demonstrates a substantial upward shift in competence levels following the multi-vector intervention. Error bars represent the standard error of the mean, highlighting the statistical significance of the gains achieved by the experimental group compared to the control group. Statistical analysis confirmed the high significance of the interaction effect between the factors of time and group affiliation. The value of the F -test was 95.74 at a significance level of $p < .001$. The size of the interaction effect was assessed as large ($\eta_p^2 = .448$). Analysis of standard errors revealed less variability of the data in the EG. In the CG, the error was ± 1.05 on the pre-test and ± 1.01 on the post-test. The EG showed even smaller errors: ± 1.02 at pre-test and ± 0.81 at post-test. The confidence interval for the between-group difference at post-test was 95% CI [10.82; 16.18]. This confirms the statistical significance and practical importance of the found differences.

4.3 Motivation and Correlation Analysis (Hypotheses H2, H3)

Figure 3 shows the relationship between the level of motivation and the increase in professional competence in EG. The histogram visualizes the dependence of learning effectiveness on the motivational component. The visual representation confirms the hypothesis of the critical role of motivation in the competence development.

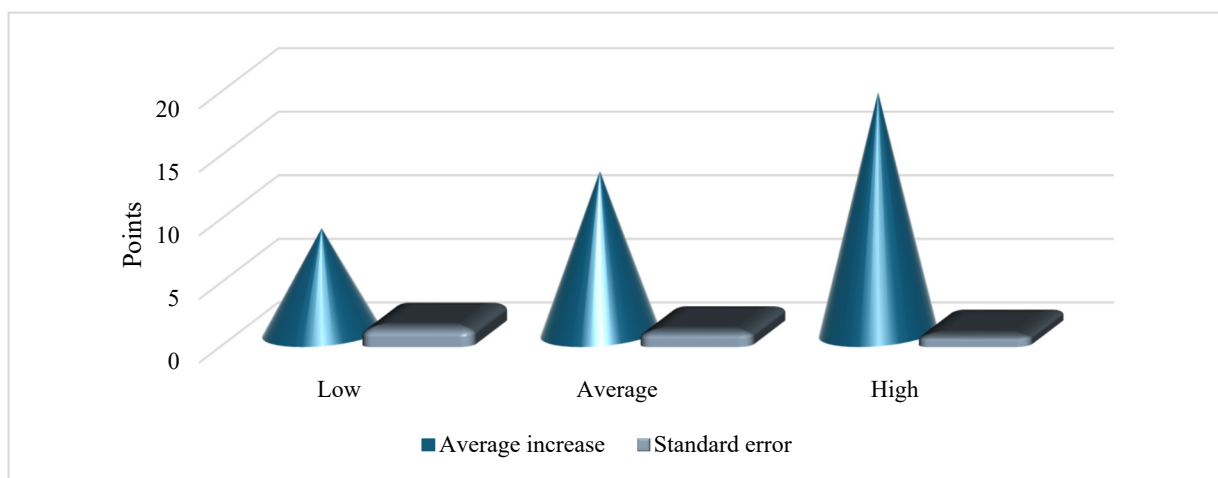


Figure 3. Relationship between motivation level and professional competence growth in EG

Source: developed by the authors based on research results

The visual trends presented in Figure 3 are further supported by Pearson correlation analysis used to examine the statistical relationship between student motivation and professional competence. In the experimental group, a significant positive correlation was identified between the value-motivational vector and overall professional competence levels, $r(58) = .64$, $p < .001$, 95% CI [.46, .77]. Specifically, intrinsic motivation showed the strongest association with operational proficiency, $r(58) = .71$, $p < .001$, suggesting that cadets with internalized professional values demonstrated superior performance in complex simulations. In the control group, this correlation was notably weaker, $r(58) = .32$, $p = .012$. These statistical findings confirm Hypothesis 3, providing empirical evidence that the strengthening of the value-motivational vector is intrinsically linked to the holistic growth of professional competence.

To further explore the predictive power of the value-motivational vector, a simple linear regression analysis was performed. In the experimental group, the regression model was statistically significant, $F(1, 58) = 41.28$, $p < .001$, accounting for 41% of the variance in professional competence ($R^2 = .416$, adjusted $R^2 = .406$). The results indicated that the value-motivational vector significantly predicted competence levels ($\beta = 0.64$, $t = 6.42$, $p < .001$). This suggests that for every one-unit increase in motivation, professional competence scores increased by 0.64 units. Multicollinearity was not a concern, as the Variance Inflation Factor (VIF) was 1.0. These findings provide robust support for the multi-vector approach, demonstrating that the integration of motivational drivers directly enhances the acquisition of military professional skills.

4.4 Expert Assessment of Practical Skills

Table 2 presents the results of expert assessment of practical skills of future reserve officers. Comparative analysis was conducted between CG and EG for three key components. Statistical data processing confirmed the effectiveness of the multi-vector approach in the development of practical skills.

Table 2. Expert assessment of practical skills (Me [IQR])

Skill Component	Control group (n=60)	Experimental group (n=60)	U-test	p-value	Effect size (r)
Decision Making	3.0 [2.0-4.0]	4.5 [4.0-5.0]	855.5	<0.001	0.78
Leadership skills	3.0 [2.0-3.0]	4.0 [4.0-5.0]	920.0	<0.001	0.72
Technical skills	4.0 [3.0-4.0]	5.0 [4.0-5.0]	780.5	<0.001	0.82
Overall score	3.3 [2.8-3.8]	4.5 [4.3-5.0]	801.0	<0.001	0.81

Source: developed by the authors based on research results

The expert assessment analysis revealed statistically significant differences in all components of practical skills. The greatest effect of the intervention was observed for technical skills ($r = .82$), where EG achieved maximum indicators. High values of the effect size ($r > 0.5$) indicate the practical significance of the differences found. The results confirm the particular effectiveness of the multi-vector approach specifically for the development of practical components of professional competence.

5. Discussion

The findings of this study align with, and may be interpreted through the lens of, social learning and self-efficacy theory (Bandura, as cited in Rumjaun & Narod, 2025). The multi-vector pedagogical intervention was designed to operationalize key theoretical mechanisms within a military context by explicitly mapping each vector to a specific source of self-efficacy. Specifically, vicarious learning was facilitated through expert modeling and peer observation during complex simulations within the cognitive-operational interface. Mastery experiences, the most influential source of self-efficacy, were systematically structured via scaffolded, project-based tasks in the operational vector, allowing cadets to transform theoretical knowledge into resilient procedural fluency through the completion of authentic, high-stakes challenges. Social persuasion was implemented through the value-motivational vector via structured feedback cycles and peer-led debriefings, which reinforced professional identity. Finally, the immersive, authentic nature of the simulation tasks was intended to help cadets manage their physiological and affective states, reducing anxiety and building confidence under pressure. This mapping demonstrates how the multi-vector approach translates abstract theoretical principles into a concrete pedagogical strategy for building professional self-efficacy in military environments.

The results provide evidence for the effectiveness of the multi-vector approach in reserve officer training. The substantial growth in professional competence observed in the experimental group aligns with established research emphasizing the necessity of integrated instructional methods in military contexts. Notably, the most pronounced improvements occurred within the practical domain, reinforcing the priority of an activity-based pedagogical framework.

These findings are consistent with the conclusions of Turemuratova and Yoldasheva (2025), where significant enhancements in practical skills through integrated teaching methods were reported. Similarly, the observed relationship between professional motivation and academic success mirrors the patterns identified by Turemuratova et al. (2025). However, a more optimistic perspective on simulation-based methods is offered compared to the research of Dudukalov et al. (2021), where limited impact on leadership development was found. This divergence likely stems from the extended implementation period used in the current experiment, which allowed for a more profound internalization of leadership behaviors.

Furthermore, the synergy identified between theoretical, training, and practical components reflects the global modernization of military education. As noted by Huluba (2021), an urgent international need exists for continuous, adaptive training systems within NATO-aligned frameworks. Through the proposal of a verified mechanism for such integration, a concrete strategy for national reserve officer training is provided to meet these contemporary requirements.

The uniqueness of this research lies in its holistic integration; whereas prior studies often analyzed instructional methods in isolation, the multi-vector approach achieves a synergistic effect. This result is attributed to the use of a differentiated motivational assessment and the simultaneous influence of multiple pedagogical vectors, leading to higher overall training efficiency compared to traditional models.

Hypothesis H1 regarding the effectiveness of the multi-vector approach was fully confirmed ($\eta^2 = 0.448$). The academic novelty of the study is the development and empirical substantiation of a comprehensive model. It integrates educational, training, and practical components. This model distinguishes the study from more specialized approaches presented in the literature.

The obtained data confirm the effectiveness of Albert Bandura's social learning theory (Rumjaun & Narod, 2025). It is applied in the context of military education, in particular regarding the importance of modelling practical situations. The strong connection between motivation and learning success also reinforces the position of the self-efficacy theory in the professional development of future officers.

The practical implications of the study are the possibility of updating training programmes for reserve officers, integrating

training and practical components, as well as the need to improve teachers' qualifications. At the same time, the theoretical implications are manifested in the development of the concept of multi-vector approaches that provide a synergistic effect, and in confirming the relevance of Albert Bandura's social learning theory. The study also deepens the understanding of the mechanisms of self-efficacy. All this makes a significant contribution to the development of the theory and practice of military education, offering an academically grounded model of reserve officer training that can be adapted to modern challenges.

6. Limitations

The conducted study has certain limitations that should be taken into account when interpreting its results. First of all, the sample was formed only on the basis of three HEIs, which may limit the generalization of the obtained data to the entire system of training reserve officers. Besides, the relatively short observation period does not allow assessing the long-term effects of the applied approaches. In particular, it was not possible to trace the stability of the acquired competencies in real conditions of military service. Despite the inclusion of various components in the multi-vector model, the study of their separate contribution to the overall result requires further, more specialized research. The results of the study may have certain limitations related to contextual and geographical factors. First, the experiment was conducted under martial law, which could affect the level of cadets' stress, motivation and general psychological stability, creating an external factor not fully controlled by the methodology. Second, the study focuses on educational institutions of one country only, so its results may be specific to the Ukrainian system of military education. Further cross-national comparisons with the practices of military HEIs of NATO member states are necessary to increase the universality and external validity of the approach.

7. Recommendations

Based on the findings and the identified limitations of this study, the following targeted recommendations are proposed for military pedagogical practice and future research:

1. Longitudinal Validation of Vector Synergy. Given that the current study utilized a convergent parallel design within a single semester, future research should employ longitudinal tracking to determine the long-term stability of the value-motivational vector. This would clarify whether the observed gains in professional identity persist after cadets transition to active duty.
2. Expansion to Diverse Cohorts. To address the selection bias inherent in our non-random convenience sample, it is recommended to replicate this multi-vector approach across diverse military specialties and mixed-gender cohorts. This would test the generalizability of the model beyond the management and technical maintenance sectors.
3. Refinement of the Operational-Cognitive Interface. Our results indicate that the strongest gains occurred when theory and practice were synchronized. Institutions should prioritize the development of hybrid simulation platforms that allow for real-time cognitive "think-aloud" interventions during operational tasks, rather than separate theoretical and practical modules.
4. Investigation of Instructor Variance. A concrete limitation noted was the potential confound of instructor expertise. Future studies should investigate the "pedagogical vector" of the instructors themselves, assessing how their specific coaching styles influence the effectiveness of social persuasion and mastery experiences within the framework.

8. Conclusion

The training of reserve officers within civilian higher education institutions faces the persistent challenge of synthesizing complex military competencies within highly condensed timeframes. Traditional modular approaches often struggle to bridge the gap between theoretical knowledge and the resilient, multi-dimensional proficiency required for modern defense environments. This study demonstrates that a multi-vector pedagogical framework, which synchronizes cognitive, operational, and value-motivational dimensions, offers a promising solution to this problem. The primary substantive takeaway is that cadets engaged in this integrated approach achieved a more robust integration of leadership principles and tactical skills, evidenced by their superior performance in high-stakes simulations compared to those in traditional curricula. These findings suggest cautious but meaningful implications for curriculum design. Specifically, military training programs in HEIs should prioritize simulation-based training (SBT) and scenario planning as central pillars that allow for the simultaneous activation of multiple learning vectors. However, given the quasi-experimental nature of this research, such changes should be implemented incrementally, with a focus on ensuring that instructional feedback cycles remain closely aligned with authentic operational demands. Looking forward, the research agenda should focus on longitudinal follow-ups to assess the long-term stability of these competence gains after cadets enter active duty. Additionally, further component-level testing is required to isolate which specific elements of the multi-vector approach, such as peer modeling or think-aloud protocols – contribute most significantly to professional self-efficacy. Such investigations will refine the model and enhance its generalizability across diverse military and security education contexts.

Acknowledgments

Not applicable.

Author contributions

Not applicable.

Funding

Not applicable.

Competing interests

Not applicable.

Informed consent

Obtained.

Ethics approval

The Publication Ethics Committee of the Redfame Publishing.

The journal's policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

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