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The impact of video on military engineering learning in wartime

Вплив відео на підготовку офіцерів інженерних спеціальностей під час війни

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Abstract

Video technologies have become a powerful tool in the system of professional training of future officers, and the research is oriented towards the revealing the potential of video may contribute to the improvement of cadets' learning outcomes during wartime significantly. Besides, the article investigates the integration of video technologies in the military engineering classroom and describes interactive video-based learning environment. A quasi-experiment with intervention and control groups was used to answer the research questions. The findings demonstrated the significance of using video in engineering education and the calculation of difference-in-differences value proved the positive impact of videos on cadets' learning outcomes. The experiment revealed eighteen teaching strategies for integrating video in the military engineering classroom. Also, we provided a detailed classification of characteristics typical for video content in military engineering education. In addition, an interactive video-based learning environment was defined. Regarding the formation of professional competence among future military engineering officers, an interactive video-based learning environment was described through certain

Анотація

Відео технології стали потужним інструментом у системі професійної підготовки майбутніх офіцерів, а дослідження, спрямовані на розкриття потенціалу відео, можуть суттєво сприяти покращенню результатів навчання курсантів під час війни. Крім того, у статті досліджено інтеграцію відео технологій у процесі вивчення військово-інженерних дисциплін та описано інтерактивне навчальне середовище на основі відео. Під час дослідження було використано квазі-експеримент із експериментальною та контрольною групами. Результати довели важливість використання відео в інженерній освіті, а розрахунок значення різниці у відмінностях довів позитивний вплив відео на результати навчання курсантів. Експеримент виявив вісімнадцять стратегій навчання для інтеграції відео під час аудиторної роботи. Також ми надали детальну класифікацію характеристик відеоконтенту, що застосовується в інженерній освіті. Крім того, було описано інтерактивне навчальне середовище на основі відео. Щодо формування професійної компетентності у майбутніх офіцерів інженерних спеціальностей, то

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requirements. The research results can be used to improve the curriculum for future military engineering officers. Also, the findings may contribute to the design of professional training programs for military educators.

Keywords: video technologies, personalized video, interactive learning environment, video lecture, video-based games.

таке середовище було досліджене через певні вимоги. Результати дослідження можуть бути використані для вдосконалення навчальної програми підготовки майбутніх офіцерів-інженерів. Також отримані дані можуть сприяти розробці програм професійної підготовки військових педагогів.

Ключові слова: відео технології, персоналізоване відео, інтерактивне навчальне середовище, відео лекція, відео ігри.

Introduction

Today, engineering is described as the solution to emerging challenges because it offers innovation to overcome serious issues and contribute to a more sustainable world. Engineering knowledge is especially important during emergencies; its forward-thinking has the potential to combat crises in impactful ways (Barabino, 2021). In this context, engineering education is an integral component of professional development that equips with the skills to build innovative technologies and infrastructure addressing critical challenges. Certain scholars view the cultivation of future engineers' professional competencies as a necessity (Buckley et al., 2021). However, there is an increasing pressure to improve the quality of engineers' training since it is often criticized for being conservative and outdated (Gumaelius et al., 2024; Teplická et al., 2022). Besides, institution-based education lacks practical projects due to its orientation towards standardized curricula (Ismail et al., 2024). In Ukraine, educational programs prioritize theoretical knowledge, leaving limited opportunities for learners (Lucenko et al., 2023). Ukrainian higher military educational institutions (HMEIs) concentrate on conventional teaching because the educational process follows the established protocols (Maistrenko et al., 2020). HMEIs are significantly challenged by the ongoing war facing the inability to maintain a regular schedule (Lavrysh et al., 2022). Also, there is a need to adapt curricula through incorporation of battlefield experiences (Bhinder, 2019).

Engineering training involves understanding complex concepts that are often abstract or multi-dimensional. That requires the use of visualization of technical processes (Bhardwaj & Gupta, 2023). Specific teaching strategies must be developed on the basis of audiovisual technologies, including laboratory experiment videos and interactive short videos (Afkar et al., 2023), video lectures (Bhardwaj & Gupta, 2023), video games (Núñez-Pacheco et al., 2023), and tutorials (Lee et al., 2018). Besides, video is a powerful self-learning tool (Bhardwaj & Gupta, 2023). In Ukraine, video technologies are used to conduct the pedagogical and psychological transformation of the educational process (Danilyan et al., 2023). Besides, Ukrainian authors paid the special attention towards the educational process in the context of large-scale military aggression (Lavrysh et al., 2022). At the same time, the use of video in military engineering education during wartime has not been sufficiently studied; this is particularly relevant for the improvement of learning outcomes of future engineers, the impact of videos on learners' engagement and their preparation to perform service functions in emergencies. While the potential of video has been theoretically recognized, there is limited empirical research on integrating video at the HMEIs. The pedagogical research on the potential of video in military engineering education seeks to address the problem of integrating video technologies in the classroom and creating an interactive video-based learning environment.

The research aim is to reveal the potentials of video in military engineering education, particularly for the improvement of learning outcomes.

The research questions answered by our work are the following:

1) How does video affect future officers' learning outcomes compared to traditional teaching methods?
2) How are video technologies integrated into the MEC?
3) What are the requirements for an interactive video-based learning environment at the HMEIs?

Therefore, this research explores how video content enhances learning outcomes in military engineering education during wartime, addressing specific challenges faced by students in HMEIs; and it offers original comprehension of the potential of video technology to bridge knowledge gaps and support the resilience of future military engineers when traditional methods are disrupted by war.

Literature Review

Being an important component of the educational process, video is integrated into classroom activities and blended courses; and it is widely used in online learning (Brame, 2016; Mamedova et al., 2023). Desai and Kulkarni (2022) explained educational video as visual and auditory material designed to enhance the level of conceptual understanding and to achieve the desired learning outcomes. Some authors emphasize that video technology presents educational information in a dynamic visual and auditory content flow (Noetel et al., 2021). There are several types of videos used within the educational process. Bhardwaj and Gupta (2023) differentiated video lectures that provide theoretical knowledge. Some authors described laboratory experiment videos (Afkar et al., 2023) and interactive videos (Desai & Kulkarni, 2022). Instructional videos are especially important for engineering education since they are focused on safety procedures (La Torre & Désiron, 2024). Other types include video games (Núñez-Pacheco et al., 2023), tutorials (Lee et al., 2018), simulation videos (Singh et al., 2020), and project-based videos (Bhinder & Protsenko, 2022).

A number of recent works explain the advantages that video brings to the engineering classroom. Bhardwaj and Gupta (2023) insisted that video complements traditional lectures reinforcing students' understanding of engineering concepts through visualizations. According to Zhu et al. (2022), video creates an immersive learning environment. Certain findings demonstrate that the use of video improves students' motivation (Lu, 2023). Self-paced online courses apply video to enhance the efficiency of the learning environment and increase students' autonomy (Jiang et al., 2019). The recent Ukrainian studies are devoted to the creation of a video-based learning environment during war. For example, video is found to be an effective tool to ensure the continuity of the educational process, particularly when the schedule is unpredictable (Lavrysh et al., 2022).

In this context, it is necessary to mention clip thinking which is a form of information perception that appears under the influence of social networks and artificial intelligence (AI) (Bushuyev, Murzabekova et al., 2024). It is characterized by information fragmentation, where preference is given to short and visually informative messages. According to Bushuyev, Korchova et al. (2024), clip thinking is determined by a short-term perspective, and a lack of analysis skills. Students having clip thinking quickly switch between different topics, perceiving information in the form of short, unrelated "clips." Some authors express worries that clip thinking causes the erosion of critical thinking skills and the creation of filter bubbles (Bushuyev, Murzabekova et al., 2024). When planning a lesson, it is important to consider clip thinking because it causes students' attention deficit, inability to concentrate for long, and loss of desire for new knowledge (Kornuta et al., 2017).

Many authors explained the role of video in increasing communication and foreign language competence (Bhinder, 2022; Kamentsev et al., 2022; Snigdha & Akter, 2023) as well as teaching the humanities (Ribeiro et al., 2016; Yildririm, 2018). At the same time, military engineering subjects require specific methodologies to prepare future officers to perform their professional functions. The findings demonstrated that the integration of video technologies occurs through various teaching strategies impacting specific engineering skills among learners. These strategies include flipped classroom (Etemi et al., 2024), blended learning (Ożadowicz, 2020), peer learning (Polkowski et al., 2020), and collaborative learning (Otoum & Alzoubi, 2024). Besides, video lectures (Bhardwaj & Gupta, 2023; Lu, 2023), project-based learning (Bhinder & Protsenko, 2022), tutorials (Lee et al., 2018), and case study (Gumaelius et al., 2024) are widely used. Some scholars insist that simulation (Feijoo-Garcia et al., 2024) and lab exercises (Onyeaka et al., 2023; Stefanova, 2014) contribute to formation of professional competence among future engineers significantly. The special attention is paid towards the use of video-based games (Núñez-Pacheco et al., 2023).

The analysis of literature indicated that video content characteristics concern high-quality visuals and interactive elements (Madariaga et al., 2021; Tretko et al., 2023). Some scholars stated that educational videos are usually clear and concise (Fyfield et al., 2019). Other findings show that video content requires contextual relevance (Nonthamand, 2024). Besides, effective video-based exercises are followed by assessment (Abdul-Rahaman & Tindam, 2024; Desai & Kulkarni, 2022). Brame (2016) stressed that cognitive load and active learning are necessary to incorporate an effective educational video. Moreover, personalized video was investigated in the works of Lee et al. (2018) and Stefanova (2014). It contributes to differentiation in teaching (Jiang et al., 2019) and building individual educational trajectories (Ralph et al., 2022).

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In this regard, exploring the peculiarities of video-based learning environment is relevant. According to Nonthamand (2024), a video-based learning environment refers to the use of videos creating learners' engagement and interaction. Also, this environment as an educational landscape where videos are introduced as the primary medium for delivering instructional content (Seago & Knotts, 2021). This approach is responsible for integrating videos within the educational process and improving an engaging learning experience when training future professionals (Gumaelius et al., 2024). The video-based learning environment in engineering education incorporates instructional videos, tutorials, recorded lectures, simulations, and demonstrations of engineering processes (La Torre & Désiron, 2024; Ueki & Guaita Martínez, 2019). Some scholars agree that this environment facilitates the formation of professional competencies among future engineers (Desai & Kulkarni, 2022). All this indicates the importance of researching the potential of using video within the educational process at the HMEIs, particularly during wartime. Since video technologies reinforce learners' understanding of engineering concepts, they develop the skills necessary to perform future professional duties, and ensure the continuity of the educational process in challenging situations.

The analysis of scientific literature revealed that video-based learning serves as an important tool for maintaining educational continuity and engagement among future military engineers during war. The recent studies highlight that video content enhances knowledge retention, provides flexible access to essential information, and supports practical skills development, especially when in-person instruction is not available. Additionally, the review indicates the requirements to educational videos and attracts attention towards clip thinking when selecting video content. The description of video-based learning environment may contribute to the enhancement of educational process at the HMEIs. Overall, the literature suggests that video technology not only improve learning outcomes under adverse conditions but also adapts to the unique needs of military engineering education in wartime.

Methodology

Research design

The research design used a quasi-experiment with intervention (IG) and control groups (CG). It involved the assessment of the impact of pedagogical phenomenon on non-randomly selected participants (Gopalan et al., 2020). Besides, a quasi-experiment is characterized by causality (Sirotová et al., 2021) referring to the relationship between an intervention (the integration of video) and the observed results (improved learning outcomes). The quasi-experiment design was chosen because it was unrealistic to conduct a randomized controlled trial at the HMEI since the existing groups (platoons) were already formed, making random selection challenging. Moreover, the HMEIs need to reflect real-life conditions as closely as possible. The quasi-experiment was useful because it was conducted in natural settings and allowed to observe the effect of educational interventions in the environment where cadets are actually trained. The IG participants were taught in the classroom where video was widely integrated, and the CG participants were involved in the traditional teaching methodology. The results were assessed based on pre- and post-test. Figure 1 shows the stages of research design based on quasi-experiment.

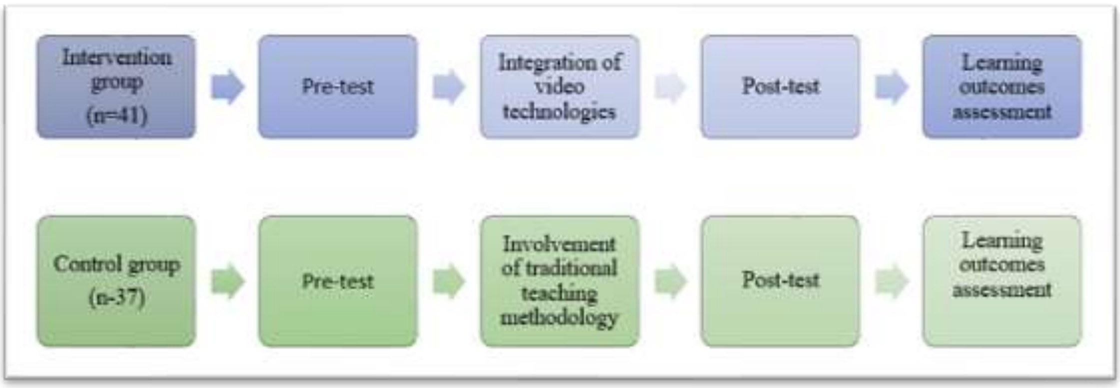

Figure 1. Research design of quasi-experiment.
Source: authors' own development.

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Sample and participants

The experiment involved 78 cadets from five study units from the Faculty of Support of Operational and Service Activity at Bohdan Khmelnytskyi National Academy of the State Border Guard Service of Ukraine. The IG involved 41 cadets, and the CG – 37. The socio-demographic results regarded the following: educational background, service level, field of specialization, level of clip thinking, learning style preferences, experience with video technologies, technological literacy, and career goals. Besides, 21 instructors of Bohdan Khmelnytskyi National Academy of the State Border Guard Service of Ukraine participated in the post-test questionnaire to provide feedback on intervention. The socio-demographic results of instructors included educational background, teaching experience duration, technological proficiency, military background, teaching style preferences, and frequency of using video.

Instrument and Procedures

To evaluate cadets' learning outcomes pre- and post-tests were used. The test consisted of 12 blocks regarding the components of future military engineers' professional competences, and valued 5 points each. The program on evaluation of the impact of video was executed in three stages: pre-test, intervention, and post-test. Pre-testing was organized on the 15 – 23rd of December, 2023. The cadets answered the questions orally, and all the results were protocolled. The intervention stage lasted between the 11th of January, 2024 and the 30th of May, 2024. During this stage, for the IG video was integrated into the classroom through different teaching strategies which were selected according to methodological guidance documents of the Department of Engineering and Technical Support. In the CG the teaching was delivered through traditional methods, such as lecture-based instruction, demonstration, field training exercises, seminars, simulation, group work, and lab learning. Table 1 shows a detailed analysis of the intervention stage. The post-test took place between the 3rd and the 5th of June, 2024. Its results provided information about the effectiveness of video and its impact on the improvement of learning outcomes of future military officers. Also, the post-test enabled to reveal the specific gaps in the structure of professional competence, and it contributed to the enhancement of the efficiency of future lessons at the HMEI during wartime.

Table 1.
The program of intervention stage

Period	Teaching strategies
11.01-24.01.2024	Video lectures
	Virtual field trip
	Interactive pause-and-discuss
25.01-7.02.2024	Simulation
	Safety protocols
8.02-21.02.2024	Lab exercises
22.02-6.03.2024	Tutorials
	Map reading
7.03-20.03.2024	Collaborative learning
	Video-based games
21.03-3.04.2024	Flipped classroom
	Annotation
4.04-17.04.2024	Blended learning
	Post-video role-playing
18.04-01.05.2024	Project-based learning
	Engineering design
2.05-15.05.2024	Case study
	Peer learning
16.05.-30.05.2024	Blended learning

Source: authors' own development.

Data Analysis

The data was analyzed using the difference-in-differences (DID) approach that provided an overview of the standard two-by-two design and examined the changes in outcomes over time between a treated and an unaffected group (Corral & Yang, 2024). We calculated the difference in outcomes before and after the integration of video in the MEC for both groups. Then these differences were compared and the effect of video was estimated. To calculate the DID value, the following formula was applied:

$$DID = (Post\text{-}test_{intervention} - Pre\text{-}test_{intervention}) - (Post\text{-}test_{control} - Pre\text{-}test_{control})$$

Then, we paid attention towards the possible assumptions and threats to results validity that can occur within the HMEI, such as simultaneous shock, group composition change, and interference between IG and CG. To avoid this, we carefully controlled for external shocks and group composition changes. We used the existing structural barriers (geographical and organizational) that reduce interaction between both groups to minimize the interference between IG and CG.

Results and Discussion

Video impact on future officers' learning outcomes compared to traditional teaching methods

Considering the previous findings, it was decided that video enables the visualization of technical processes (Afkar et al., 2023), and enhances engagement (Feijoo-Garcia et al., 2024). Additionally, video contributes to flexible, self-paced learning and improves knowledge transfer (Jiang et al., 2019). Its potential to make the educational process more engaging provides many benefits over traditional classroom (Dehne & Gröschner, 2023; Núñez-Pacheco et al., 2023). Video supplements instruction and, therefore, increases comprehension, retention, and discovery in engineering education (Lee et al., 2018). According to Stefanova (2014), video in engineers' training illustrates the explanation with examples and presents real-life experiences. In the Ukrainian context, video technologies maintain the continuity of the educational process during emergencies (Lavrysh et al., 2022; Mamedova et al., 2023).

Similarly, the experiment demonstrated the significance of using video in military engineering education, and the calculation of the DID value proved that videos affect cadets' learning outcomes differently. For example, LO_9 and LO_{12} showed the most significant changes when video was integrated. LO_1, LO_6, LO_7, and LO_{10} revealed slightly lower results, but DID proved that the use of video had a high potential for the enhancement of training. LO_2, LO_3, LO_4, LO_5, LO_8, LO_{11} achieved comparatively small increases, but they demonstrated that even infrequent use of video leads to positive changes. Therefore, answering the first research question, the findings proved that video positively impacts future officers' training and provides real-life simulations. Also, video equips future engineers with practical skills and they are prepared to perform complex tasks in high-pressure situations. Table 2 analyzes the impact of using video upon future officers' learning outcomes in comparison with traditional teaching approaches.

Table 2.
Impact of using video on learning outcomes

Code	Learning outcome	IG			CG			DID
		Pre-test	Post-test	Change	Pre-test	Post-test	Change	
LO_1	Technical expertise	3,457	3,721	+0,264	3,381	3,208	-0,173	0,437
LO_2	Military infrastructure design	4,006	4,309	+0,303	3,978	4,103	+0,125	0,178
LO_3	Explosives and demolition proficiency	4,382	4,769	+0,387	4,405	4,555	+0,150	0,237
LO_4	Combat engineering skills	3,897	4,236	+0,339	3,247	3,389	+0,142	0,197
LO_5	Project management	2,389	3,314	+0,925	2,509	3,116	+0,607	0,318
LO_6	Leadership	3,451	4,119	+0,668	3,489	3,582	+0,093	0,575
LO_7	Engineering reconnaissance	2,087	2,975	+0,888	2,431	2,889	+0,458	0,430
LO_8	Logistics support	3,153	3,808	+0,655	2,786	3,215	+0,429	0,226
LO_9	Use of military equipment	3,476	4,879	+1,403	2,601	2,907	+0,306	1,097
LO_{10}	Risk and safety management	2,677	3,585	+0,908	3,012	3,344	+0,332	0,576
LO_{11}	Communication skills	3,865	4,603	+0,738	3,456	3,897	+0,441	0,297
LO_{12}	Technology integration	3,008	3,962	+0,954	3,238	3,256	+0,018	0,936
$LO_{\bar{x}}$	Average value	3,319	4,023	+0,704	3,211	3,455	+0,244	0,460
LO_{Σ}	Summary value	39,839	48,280	+8,441	38,533	41,461	+2,928	5,513

Source: authors' own development.

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Integration of video technologies into the MEC

Previously, we found that in engineering education, video technologies are used in flipped classroom (Deng et al., 2024) and blended learning (Ożadowicz, 2020). Other teaching strategies include video lectures (Bhardwaj & Gupta, 2023), project-based learning (Bhinder & Protsenko, 2022), tutorials (Ueki & Guaita Martínez, 2019), simulation (Feijoo-Garcia et al., 2024), and lab exercises (Onyeaka et al., 2023). Gumaelius et al. (2024) mentioned that the integration of video in case studies contributes to the reinforcement of students' technical skills. Recent sources describe collaborative learning and peer learning (Polkowski et al., 2020). A number of researchers investigated video-based games (Núñez-Pacheco et al., 2023). For comparison, the experiment revealed eighteen teaching strategies used to integrate video in the MEC. Accordingly, twelve characteristics of video content were selected. The findings revealed that TS_1 is mainly characterized by high-quality visuals, conciseness, contextual relevance, and cognitive load management, TS_2 – real-life examples, and high-quality visuals, TS_3 – the use of interactive elements. TS_4, TS_{10} and TS_{11} required interactive elements, TS_5 and TS_8 – high-quality visuals and clear materials, TS_7 – narration quality. TS_9 is effective when the video is clear and allows assessment. TS_{12} and TS_{14} required contextual relevance. At the same time, TS_{13} was characterized by conciseness, TS_{15} – feedback. Also, the results showed that TS_{16}, TS_{17}, TS_{18} need contextually relevant video, rapid feedback and objective assessment. Table 3 shows the cumulative results on teaching strategies used to integrate video.

Table 3.
Teaching strategies used to integrate video

Code	Teaching strategies	Instructors' responses											
		Interactivity	Real-life examples	Personalization	High-quality visuals	Clarity	Conciseness	Contextual relevance	Feedback	Assessment	Narration quality	Microlearning	Cognitive load management
TS_1	Interactive video lectures	11	7	4	21	20	16	18	3	12	17	9	16
TS_2	Virtual field trip	1	21	0	19	12	2	7	2	1	12	0	5
TS_3	Pause-and-discuss	19	6	11	3	4	6	8	17	13	0	4	2
TS_4	Simulation videos	16	15	11	13	12	9	6	7	8	2	9	5
TS_5	Safety protocols	3	20	3	18	17	15	8	14	3	16	1	3
TS_6	Lab exercises	2	14	5	6	9	11	18	11	16	2	2	5
TS_7	Tutorials	6	11	12	10	12	16	11	10	18	21	0	12
TS_8	Map reading	3	10	14	18	13	2	12	9	17	12	9	3
TS_9	Collaborative learning	14	6	17	13	18	12	17	8	16	11	2	11
TS_{10}	Video-based games	19	17	15	12	14	17	12	5	15	9	4	5
TS_{11}	Flipped classroom	18	9	8	16	11	16	16	12	14	6	13	8
TS_{12}	Annotation	1	2	9	15	10	15	20	13	17	19	15	19
TS_{13}	Blended learning	11	6	10	12	9	19	15	16	17	13	17	13
TS_{14}	Post-video role-playing	2	13	13	10	5	11	18	6	8	14	4	3
TS_{15}	Project-based learning	8	11	6	7	3	17	19	19	17	11	5	8
TS_{16}	Engineering design	6	10	17	13	14	19	21	18	19	18	13	17
TS_{17}	Case study	12	7	14	15	12	18	17	15	18	7	7	14
TS_{18}	Peer learning	3	5	7	11	17	21	16	12	11	13	9	6

Source: authors' own development.

The requirements for an interactive video-based learning environment at the HMEIs

Many scientific works are devoted to video-based learning environment. It was found that the main characteristic of this environment is its ability to combine video with interactive elements (Desai & Kulkarni, 2022; Madariaga et al., 2021). An interactive video-based learning environment offers real-life simulations and practical exercises on professional situations (Lowe et al., 2024). Obviously, an interactive video-based learning environment improves learning outcomes and facilitates the formation of professional competencies among future engineers (Desai & Kulkarni, 2022).

The post-test results demonstrated that an interactive video-based learning environment refers to an organizational and pedagogical setting where videos are combined with interactive components. The environment encourages active learning and allows cadets to test their knowledge or skills through incorporated assessment mechanisms, and explore military engineering concepts. Moreover, an interactive video-based learning environment suggests engagement, enhanced attention, development of specific engineering skills, and develops multitasking among future officers. Also, this environment simulates realistic military scenarios, real-life in-unit cooperation and interoperability. Table 4 presents the requirements for the creation of an efficient interactive video-based learning environment and its contribution to the formation of professional competencies among future officers.

Table 4.
Requirements for interactive video-based learning environment

Requirements	Formation of professional competencies	Instructors' responses
Interactive elements and game-based learning	1) Active engagement.	14
	2) Simulation of tactical decisions.	16
	3) Development of critical thinking.	19
	4) Increased motivation.	20
Personalization	1) Adaptation to cadets' individual needs and learning styles.	15
	2) Enhanced problem-solving skills.	17
	3) Active involvement.	16
	4) Use of learner-centered content.	8
High-quality audio and visuals	1) Increased attention to technical details.	12
	2) Experience of near-real conditions.	16
	3) Increased retention.	19
Collaboration activities	1) Teamwork and communication skills.	20
	2) Enhancement of problem-solving and critical thinking.	17
	3) Simulation of real-life in-unit cooperation and interoperability.	16
	4) Increased engagement and motivation.	14
	5) Development of leadership.	18
Real-life scenarios	1) Applying theoretical knowledge in practical situations.	20
	2) Improved decision-making.	16
	3) Preparation for unpredictable circumstances.	17
	4) Improved military engineering project management.	19
Problem-based learning	1) Critical thinking and problem solving.	16
	2) Involvement in realistic military scenarios.	14
	3) Enhanced collaboration.	19
	4) Promotion of active learning.	18
War-time training	1) Engagement in realistic, war-time scenarios.	19
	2) Adaptation to combat situations.	18
	3) Experiencing the physical and emotional challenges.	17
	4) Training of specific war-time engineering tasks.	20
Clip thinking considering	1) Enhanced focus and knowledge retention.	16
	2) Efficient use of time.	17
	3) Increased engagement in the classroom.	11
	4) Stress management.	14
	5) Realistic visualization of military engineering tasks.	15
Cognitive load reduction	1) Focus on the most critical information.	13
	2) Prevention of mental burnout.	15
	3) Multitasking in war-time operations.	14

Source: authors' own development.

Therefore, the experiment proved that the correct use of video has a great potential for improvement of cadets' learning outcomes. The IG demonstrated that the incorporation of video technologies within the educational process has a positive impact and enhances practical skills necessary for carrying out engineering tasks during combat and non-combat operations. To make video a powerful educational tool, it is important to integrate video-based activities through specific teaching strategies. Besides, video content should possess certain characteristics to maximize the educational process. At the same time, specific attention should be paid to creating an interactive video-based learning environment at the HMEI.

The findings can be used to improve the curriculum oriented towards training of future military engineering officers to incorporate video technologies within the educational process during war more effectively. The experiment results can also be considered when developing the courseware and methodological materials at the engineering departments of the HMEIs. In addition, the research outcomes can be applied to design professional training programs for military educators to equip them with the technological and pedagogical skills.

Conclusions

The research found that the use of video has a significant impact upon the improvement of learning outcomes in military engineering education through the visualization of engineering concepts and technical processes, enhancement of cadets' engagement, and presentation of real-life experience. It was found that the formation of professional competence among future military officers with the use of educational video requires the implementation of specific teaching strategies in the MEC. To unlock the potential of video it should possess certain characteristics, such as interactive elements, real-life examples, personalization, high-quality visuals, clarity, conciseness, contextual relevance, feedback, assessment mechanisms, narration quality, microteaching, and cognitive load management. Besides, it was concluded that it is important to create an interactive video-based learning environment that enables future military engineers to engage with the educational materials actively and to enhance the cultivation of military engineering skills necessary to carry out professional tasks under high-pressure conditions.

The research contributed to the detailed examination of the support of video technologies for the educational needs of future military engineering officers during war. When focused on the adaptability and accessibility of video as an effective educational tool, the study provides unique information on the potential of video to enhances learners' engagement, their knowledge retention, and the development of technical skills even when traditional learning environment is disrupted. The study further emphasizes the advantages of integrating video into the curriculum, such as the creation of access to educational materials, and simulating practical experiences that are important for building future military engineers' professional competence. Besides, this research stresses upon the transformative role of video in military engineering learning during wartime, demonstrating its impact on sustaining learning outcomes during emergencies. The study highlights the importance of effectively integrating video into the curricula of HMEI to ensure continuity, resilience, and adaptability of the educational process. The quasi-experiment exploring the enhancement of learning outcomes through in military engineering education during wartime, addresses specific challenges faced by students in HMEIs. Besides, it offers original comprehension of the potential of video technology to maintain the training of future military engineers when traditional methods are disrupted by war.

Despite the article explaining the potential of video to improve learning outcomes in military engineering education, it has several limitations. Firstly, the findings are influenced by the specific context – the State Border Guard Service of Ukraine, and they may not be fully applicable for other HMEIs since they are oriented toward different military missions set by various branches of the Armed Forces. Secondly, the improvement of practical skills of future officers was slightly challenging because professional military engineering tasks are rapidly changing due to combat and non-combat conditions. As a result, educational videos should be constantly updated to consider the battlefield experience.

The study offers the practical applications that can significantly enhance both curriculum design and the training of military educators. For curriculum design, the study recommends incorporating video content that cover essential engineering concepts, operational procedures, and simulations of real-life scenarios. For instance, recorded tutorials and interactive demonstrations can be integrated into the lesson plans, and, as a result, learners have the possibility to revisit complex material at their own pace, that if very important during interruptions caused by wartime circumstances. Additionally, different teaching strategies can be used to create an interactive video-based learning environment that encourages cadets to participate in the classroom.

The findings support preparing instructors to use video technology as an effective teaching tool and a means of engagement. Educators can be trained to create high-quality video content that guide future military engineers through various simulated tasks. For example, a military engineering course could use videos to illustrate machinery maintenance to explore each machine component interactively. The study emphasizes that video-based learning contributes to form critical skills among learners and deliver practical instruction, providing a possibility for HMEIs to enhance the continuity of educational process through effective video integration.

Future research can be aimed at comparative studies between traditional teaching methods and video-based learning to evaluate their relative effectiveness in different military engineering disciplines. Besides, it is important to investigate the impact of personalized video on the learning outcomes of individual cadets in military engineering education.

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