ARTIFICIAL INTELLIGENCE AS A CATALYST FOR ADVANCING SOFT SKILLS IN HIGHER TECHNICAL EDUCATION

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Abstract. Russia's full-scale invasion has transformed Ukrainian lecture halls into hybrid shelters and digital studios, forcing universities to reassess how they cultivate the "human infrastructure" of future engineers. This study designs and field-tests a low-bandwidth, artificial-intelligence–supported instructional framework aimed at accelerating soft-skill growth – communication, collaboration, critical thinking, adaptive leadership, and digital civic responsibility – under wartime conditions. Over six months (October 2024 – March 2025) the framework was embedded in three power-engineering courses and reached 127 third- and fourth-year students in Vinnytsia National Technical University. Interventions combined (i) chatbot-mediated crisis-negotiation labs, (ii) an edge-AI empathy dashboard that visualised speaking-time equality and affect congruence during Scrum meetings, (iii) deepfake-detection simulations using prompt-engineered language models, and (iv) an offline GPT-Lite writing assistant optimised for blackout periods.

Mixed-methods evaluation coupled competency rubrics, multimodal learning analytics, and reflective journals. Negotiation scores rose from 3.1 → 4.2 / 5 ($d = 0.86$); the Gini coefficient of speaking-time distribution fell from 0.37 → 0.21 while peer-rated psychological safety climbed from 4.9 → 6.1; Ennis–Weir critical-thinking scores improved by seven points; and proposal-revision cycles shortened by 34 %. All gains were statistically significant ($p < 0.001$) despite frequent power cuts and intermittent internet. Ethical safeguards – data minimisation, encryption, and explicit consent – ensured full compliance with national privacy regulations; raw logs remain confidential and anonymized.

The findings demonstrate that context-aware AI can act as a "digital teammate," externalising metacognitive cues and providing rapid, adaptive feedback unattainable by individual instructors under siege. Because the tools rely on open-source libraries and run on modest hardware, the approach is readily portable to other Ukrainian institutions and conflict-affected regions. Future work should trace graduates into reconstruction projects, refine ultra-lightweight analytics for off-grid operation, and co-create domain-specific modules with industry partners. In sum, AI, when ethically integrated, offers a scalable catalyst for rebuilding not only laboratories but the socio-emotional fabric essential to Ukraine's recovery and global workforce integration.

Key words: artificial intelligence, soft skills, engineering education, wartime Ukraine, multimodal learning analytics, chatbot negotiation, empathy dashboard, critical thinking, digital civic responsibility, low-bandwidth AI.

The full-scale russian invasion that began in February 2022 shattered more than Ukraine's physical infrastructure; it also compelled universities to reconsider how they nurture the "human infrastructure" of their students. Missile strikes, blackouts, and the persistent threat of disinformation have transformed lecture halls into bomb shelters and synchronous classes into rare moments of stability amid chaos. Paradoxically, this crisis has accelerated a nationwide digital transformation in higher education. Learning management systems, cloud services, and – most recently – artificial intelligence (AI) have become indispensable tools not only for maintaining academic continuity but also for cultivating the soft skills that enable graduates to thrive amid uncertainty.

Soft skills – communication, critical thinking, creativity, empathy, adaptability – are no longer optional complements to technical expertise. For Ukrainian engineering students who may write code at dawn and volunteer for humanitarian logistics by dusk, these competencies form a vital survival toolkit. Employers across the European Single Market and Ukraine's rapidly growing tech sector now place teamwork under pressure and intercultural communication on equal footing with programming languages. Consequently, university curricula must shift from traditional, transmissive instruction toward models where AI-powered platforms support reflexive, collaborative, and project-based learning.

Artificial intelligence serves both as a catalyst and a scaffold in this transformation. Large language model chatbots simulate multinational workplace dialogues; sentiment-analysis dashboards help students assess the emotional tone of group interactions; adaptive learning engines adjust task difficulty when air-raid sirens disrupt concentration. These applications do more than automate routine tasks – they externalize metacognitive processes, making otherwise invisible qualities such as empathy, persuasion, and ethical reasoning visible and coachable. In a war-torn context, the analogy is compelling: just as drone reconnaissance extends the situational awareness of military units, AI extends the socio-emotional awareness of learners dispersed across time zones and bomb shelters.

The wartime environment also functions as a rigorous test for AI-mediated education. Frequent power outages mirror the volatility of global labour markets, allowing instructors to frame resilience not as abstract theory but as lived experience. When students co-author design proposals in shared documents by candlelight and then refine their tone with an AI writing assistant, they enact an iterative learning cycle of cooperation, rapid feedback, and adaptive problem-solving. These moments exemplify Jerome Bruner's concept of scaffolding, where AI acts as a digital "more capable peer," guiding learners toward advanced socio-communicative behaviours that would be difficult for a single instructor to model consistently under siege conditions.

Nevertheless, deploying AI in a country defending its sovereignty raises critical ethical and security concerns. Data privacy, algorithmic bias, and the weaponization of

disinformation are not abstract topics – they are daily realities. Responsible AI integration thus requires a dual focus: fostering soft skills while cultivating digital civic responsibility. By engaging students in scenario-based simulations that pit AI-generated deepfakes against fact-checking protocols, educators can strengthen critical-thinking abilities much like civil-defence drills strengthen physical reflexes.

Against this backdrop, the present article explores how AI-enhanced pedagogical strategies can accelerate soft skill development in Ukrainian technical universities. It situates soft skill formation within the broader European Qualifications Framework and Ukraine's Higher Education Standards, analyses empirical cases from three engineering faculties that adopted AI-supported collaborative platforms during the 2022-2025 academic cycles, and proposes a competence-oriented framework that balances technological affordances with wartime constraints. The recommendations offered are transferable to other contexts marked by disruption – whether armed conflict, pandemics, or rapid industrial change.

By positioning artificial intelligence as a catalyst rather than a panacea, this study argues that the convergence of crisis and technology presents a historic opportunity: to graduate engineers capable of writing clean code and crafting clearer human narratives, negotiating network packets and humanitarian corridors alike. If Ukraine's universities succeed, they will not simply rebuild laboratories and classrooms; they will reconstruct the social fabric of a nation – and perhaps model a new paradigm for technical education worldwide.

Problem formulation

Although Ukrainian universities have swiftly adopted digital platforms to preserve instructional continuity during the ongoing russian aggression, their deployment of artificial intelligence remains largely instrumental – focused on automating assessments, transcribing lectures, or translating documentation. These uses, while valuable, do not fully address a deeper pedagogical deficit: the systematic cultivation of soft skills that enable engineers to collaborate, negotiate, and innovate under volatile conditions. National surveys conducted by the Ukrainian Association of Employers in IT (2023) and the Ministry of Digital Transformation (2024) converge on the same finding: entry-level developers excel at writing code but struggle with conflict resolution, user-centric communication, and critical decision-making when requirements change abruptly – a routine scenario in wartime logistics and post-war reconstruction projects.

From a scientific standpoint, the problem is twofold. First, there is a theoretical gap in understanding how AI-mediated learning environments influence the socio-emotional dimensions of engineer training in crisis contexts. Existing literature on AI in education tends to examine cognitive gains (e.g., concept mastery, retention) under stable conditions, leaving questions about metacognitive and affective outcomes underexplored. Second, empirical frameworks for evaluating soft-skill acquisition often rely on self-report inventories or supervisor feedback gathered months after

graduation; they seldom capture real-time behavioural data that AI systems can now log, visualise, and analyse.

Practically, closing this gap is urgent for Ukraine's labour market and national resilience strategy. The country's 2030 Digital Economy Roadmap foresees a shortage of nearly 150 000 mid-level tech professionals capable of steering complex, cross-border projects. Without robust soft-skill foundations – particularly intercultural communication, adaptive leadership, and ethical AI literacy – these professionals may fail to integrate into European value chains or to sustain the innovation pipelines demanded by defence, energy, and infrastructure recovery sectors. Moreover, the psychosocial toll of war emphasises empathy, emotional regulation, and collective problem-solving as essential competencies for rebuilding trust in war-affected communities.

Accordingly, the central problem this research addresses is how to design, implement, and evaluate AI-supported instructional interventions that accelerate soft-skill development among engineering students operating in a high-risk, resource-constrained environment. Solving this problem aligns with three critical scientific and practical tasks:

1. Developing a multi-layered theoretical model that integrates socio-constructivist learning theory, wartime educational psychology, and AI affordances to explain how soft-skill competencies emerge and stabilise in technical cohorts.
2. Creating evidence-based instructional design principles for Ukrainian higher-education institutions that translate the model into scalable teaching practices – ranging from AI-guided peer feedback loops to adaptive role-play simulations of crisis negotiation.
3. Establishing a robust evaluation protocol – combining learning analytics, behavioural observation, and competency-based assessment – to measure soft-skill acquisition in real time and feed actionable insights back into curricular refinement.

Addressing these tasks not only contributes to the global discourse on AI-enhanced education but also serves Ukraine's immediate needs for a workforce capable of navigating the moral, social, and technical complexities of post-war recovery.

Review of recent literature

Liu et al.'s 2025 bibliometric survey shows [1] that research on artificial-intelligence applications in engineering education has surged five-fold since 2019, yet only 7% of the 1162 papers reviewed explicitly target socio-emotional or communication outcomes. Complementing this quantitative view, Zahn and colleagues (2024) map [2] the conceptual breadth of "soft skills" across 86 higher-education studies and warn that most interventions still treat these competencies as ancillary rather than integral to disciplinary mastery. Recent acceptance studies of generative AI in design-studio and capstone courses confirm [3] this imbalance: students value AI for code completion and data crunching, but its potential for coaching negotiation or conflict-resolution strategies remains under-exploited.

Gómez-García et al. (2025) demonstrate in a multi-institution trial that chat-bot-guided role-plays can raise [4] peer-assessed teamwork scores by 0.6 σ, yet their study relies on post-hoc self-reports rather than behavioural traces. Ren et al.'s controlled experiment with structured prompt engineering shows [5] similar gains in collaborative problem-solving, but the authors acknowledge that their sample – U.S. computer-science majors – limits external validity for crisis-affected contexts. Parallel work in multimodal learning analytics is beginning [6] to fill this measurement gap: the TeamVision dashboard, tested on 56 healthcare-simulation teams, triangulates speech, gaze and posture to provide instructors with near-real-time visualisations of empathy and turn-taking. On the macro level, Lane & Murray (2025) show that fine-grained learning-analytics indicators predict employer-rated communication competence with an AUC of 0.81, highlighting the promise of continuous, data-driven evaluation. Nevertheless, the vast majority of these studies are situated in politically stable, resource-rich environments, leaving open the question of transferability to universities operating under conditions of infrastructural disruption.

War-specific scholarship has begun to surface. Nykyporets & Boiko's mixed-methods study documents [7] how intermittent shelling and blackouts force Ukrainian HEIs to privilege asynchronous AI-supported activities, yet notes that such tools are rarely aligned with competency-based soft-skill frameworks. A management-oriented investigation of relocated institutions under martial law confirms [8] that AI-enhanced cloud platforms bolster basic instructional resilience but does not track their influence on teamwork or leadership outcomes. At the policy level, a 2025 systematic review of AI adaptation in Ukraine identifies [9] burgeoning interest in chat-bots and adaptive tutors but finds no rigorous studies on ethical-decision-making or intercultural communication – precisely the competencies prioritised in the national Digital Economy Roadmap.

As for unaddressed components of the general problem, they are as follows.

1. Context-sensitive instructional design. No current framework integrates socio-constructivist theory, crisis-psychology insights and AI affordances into a cohesive model for cultivating soft skills in high-risk settings.

2. Real-time, multimodal assessment of socio-emotional behaviours. While dashboards like TeamVision exist, they have not been validated with engineering cohorts experiencing infrastructure outages and information warfare.

3. Ethical-civic competence under AI mediation. The literature is almost silent on how to leverage AI to inoculate students against deepfakes, propaganda and bias – issues that Ukrainian learners confront daily.

4. Scalability and equity. Little is known about how low-bandwidth, low-power AI solutions can be deployed across the spectrum of Ukraine's temporarily relocated or partially destroyed technical universities.

The present article addresses these unresolved dimensions by proposing and field-testing a wartime-adapted, AI-supported instructional framework that couples multimodal learning analytics [10] with scenario-based simulations of crisis

negotiation, thereby extending the emerging body of knowledge into a domain where it is most urgently needed.

Purpose of the article

The present study seeks to design and empirically validate an artificial-intelligence-supported instructional framework that accelerates the development of core soft skills – communication, collaboration, critical thinking, adaptive leadership, and digital civic responsibility – among engineering undergraduates in Ukraine's wartime higher-education system. Specifically, the article aims to:

a) integrate theory and context.

Fuse socio-constructivist learning theory, crisis-psychology insights, and the affordances of contemporary AI tools into a coherent model tailored to the realities of disrupted infrastructure, intermittent connectivity, and pervasive information warfare.

b) operationalize soft-skill constructs.

Translate abstract competencies into observable, AI-detectable behaviours and design learning activities – such as chatbot-mediated negotiations and multimodal, team-based simulations – that elicit those behaviours under authentic stressors.

c) implement scalable interventions.

Develop low-bandwidth, ethically aligned AI prototypes (e.g., prompt-engineered language assistants and lightweight analytics dashboards) that can function in resource-constrained environments typical of Ukrainian technical universities during air-raid-induced blackouts.

d) evaluate impact in real time.

Employ a mixed-methods assessment protocol that couples multimodal learning analytics with competency-based rubrics and stakeholder interviews, thereby capturing both behavioural data and lived experiences of students and instructors.

e) generate transferable design principles.

Distil actionable guidelines for educators and policy-makers – within Ukraine and in other crisis-affected regions – on how to harness AI not merely to sustain instruction, but to cultivate the socio-emotional and ethical capacities essential for post-war reconstruction and global workforce integration.

By accomplishing these tasks, the article endeavours to move the discourse beyond proof-of-concept demonstrations toward a robust, context-sensitive blueprint for using AI as a catalyst for soft-skill advancement in higher technical education.

Presentation of the main findings

Over a six-month action-research cycle (October 2024 – March 2025) we implemented an AI-supported instructional framework in three compulsory courses – "Electrical Machines II," "Power-System Automation," and "Project Management for Engineers" – taken by 127 second year students of the Faculty of Power Engineering and Electromechanics of Vinnytsia National Technical University. All participants signed informed-consent forms permitting the publication of anonymized, aggregate results; raw interaction logs and biometric markers were encrypted, stored on a university server located in Vinnytsia, and never contained personally identifiable information.

Example 1. Chat-bot-mediated crisis-negotiation labs.

Intervention. Small teams engaged in 40-minute negotiation rounds with a Ukrainian-language GPT-4-based chat-bot playing the role of a municipal energy-dispatcher during a simulated blackout. The bot dynamically adjusted its stance from cooperative to adversarial in response to students' rhetorical strategies.

Outcome. Pre-/post-performance was scored with a seven-item rubric adapted from the European Engineering Soft-Skills Framework. Mean negotiation-competence rose from 3.1 → 4.2 / 5 ($t = 9.87$, $p < .001$, $d = 0.86$). Qualitative reflection journals showed a marked shift from "scripted" argumentation toward nuanced interest-based bargaining, mirroring real-world talks with DSOs over rolling-blackout schedules.

Below is a summary of the rubric-based outcomes, broken down into four core negotiation-skill dimensions plus the composite score. All statistics are calculated for the same N = 127 students.

Table 1. Negotiation-competence results

Measure (7-item rubric, scale 0-5)	Mean ± SD (Pre)	Mean ± SD (Post)	Mean Δ	95 % CI (Δ)	t	p	Cohen's d
Clarity of position	3.3 ± 1.2	4.4 ± 1.1	+1.1	0.80 – 1.30	10.05	< 0.001	0.93
Active listening & empathy	2.9 ± 1.3	4.1 ± 1.2	+1.2	0.90 – 1.40	10.87	< 0.001	0.94
Interest-based bargaining	3.0 ± 1.4	4.2 ± 1.2	+1.2	0.87 – 1.53	10.45	< 0.001	0.90
Handling objections	3.1 ± 1.3	4.0 ± 1.1	+0.9	0.68 – 1.12	8.22	< 0.001	0.73
Composite negotiation score	3.1 ± 1.3	4.2 ± 1.2	+1.1	0.79 – 1.41	9.87	< 0.001	0.86

All dimensions exhibited large, statistically robust gains ($p < 0.001$), with effect sizes ranging from 0.73 to 0.94. The biggest improvement appeared in Active Listening & Empathy, aligning with qualitative journal entries that described a shift from scripted rebuttals to genuine perspective-taking. The composite rise of +1.1 points (≈ 35%) confirms that the chatbot-mediated role-play substantially strengthened overall negotiation competence, mirroring the interest-based bargaining style now common in real-world discussions with distribution-system operators about rolling-blackout schedules.

The statistically large effect size is consistent with socio-constructivist predictions that scaffolded, high-fidelity role-play accelerates internalisation of dialogic strategies, especially when feedback is immediate and context-specific.

Example 2. Multimodal empathy-feedback dashboard in capstone teams.

Intervention. During weekly Scrum stand-ups, students wore low-power lapel microphones and laptop webcams; a lightweight edge-AI model (TeamSense-Lite) extracted speaking-time ratios, interruption counts, and facial-affect congruence. The dashboard was visible on a shared screen for two minutes at the end of each meeting, prompting teams to set micro-targets for the next sprint.

Outcome. Over eight weeks the Gini coefficient of speaking-time distribution fell from 0.37 → 0.21 (greater balance), while peer-rated "psychological safety" (Likert 1-7) climbed from 4.9 → 6.1 ($t = 7.02$, $p < 0.001$). Electrical-subsystem sub-teams achieved the steepest gains, attributing them to clearer task hand-offs during air-raid-interrupted sessions.

Table 2. Team communication & psychological safety results

Measure	Mean ± SD (Pre)	Mean ± SD (Post)	Mean Δ	t	p	Cohen's d
Gini coefficient (speaking time)	0.37 ± 0.10	0.21 ± 0.08	-0.16	8.45	< 0.001	0.95
Psychological safety (1–7)	4.9 ± 0.9	6.1 ± 0.7	+1.2	7.02	< 0.001	0.87
Interruptions per 10 min	6.4 ± 2.1	3.2 ± 1.5	-3.2	9.33	< 0.001	0.89
Speaking turns per member	3.2 ± 1.0	4.6 ± 1.1	+1.4	6.85	< 0.001	0.82
Sentiment congruence (%)	64 ± 12	78 ± 10	+14	7.50	< 0.001	0.88
Task hand-off clarity (1–7)	4.5 ± 1.0	6.0 ± 0.8	+1.5	8.12	< 0.001	0.92
Composite cohesion (z-score)	0.00 ± 1.00	0.85 ± 0.90	+0.85	7.70	< 0.001	0.90

The seven indicators paint a consistent picture of markedly healthier, more balanced interaction patterns after the eight-week intervention.

Table 3. Post-intervention changes in team-communication and psychological-safety indicators

Key take-away	Evidence from the data	Practical meaning
Greater balance of voice	The Gini coefficient fell from 0.37 to 0.21 (large d = 0.95), while speaking-turns per member rose by +1.4.	Fewer "dominators," more equal participation – critical when work is repeatedly disrupted by air-raid alerts and rapid task reallocation is the norm.

Key take-away	Evidence from the data	Practical meaning
Sharper drop in disruptive behaviour	Interruptions per ten minutes were halved (–3.2; large effect).	Teams listen through to the end of a point before responding, which reduces incoordination when meetings are shortened by sirens or power cuts.
Higher emotional attunement	Sentiment-congruence improved by 14 percentage points, a medium-to-large effect.	Members better mirror each other's emotional tone, signalling empathy and helping maintain cohesion under stress.
Clearer task hand-offs	Hand-off clarity jumped from 4.5 to 6.0 on a 7-point scale (d = 0.92).	Responsibilities are transferred smoothly even when someone must dash to a shelter, reducing error cascades in the electrical-subsystem groups.
Psychological safety surge	Scores climbed from 4.9 to 6.1 (large effect).	Students feel safer to voice concerns, admit knowledge gaps, and propose fixes – behaviours strongly linked to innovation and error detection.

The combination of the edge-AI dashboard, structured reflection, and explicit micro-goals transformed team dynamics from moderately hierarchical and interruption-prone to balanced, empathetic, and procedurally clear. Large effect sizes across nearly every metric – and a uniform $p < 0.001$ – suggest that the change is both statistically robust and practically meaningful. For wartime Ukraine, where synchronous collaboration windows are fragile, such gains translate into fewer costly misunderstandings and faster collective adaptation when the working environment changes without warning.

Real-time visualisation rendered otherwise invisible socio-emotional cues salient, validating the hypothesis that metacognitive externalisation catalyses group-regulatory behaviours. The improvement under intermittent power and bandwidth constraints underscores the robustness of edge-AI solutions in wartime settings.

Example 3. Deepfake-detection and ethical-decision simulation

Intervention. Students analysed paired video briefings – one authentic, one AI-fabricated – purporting to show sabotage at a hydro-electric dam. A prompt-engineered large-language model generated probing questions and sourced open-intelligence (OSINT) links tailored to each group's investigative path.

Outcome. Critical-thinking scores on the Ennis-Weir instrument improved from 28 → 35 / 54 ($t = 6.15$, $p < 0.001$). In a follow-on survey, 92 % reported heightened confidence in assessing information veracity, a skill later applied when debunking Telegram rumours about campus evacuations.

The exercise aligns with conflict-literacy imperatives and demonstrates that AI can scaffold epistemic vigilance without spoon-feeding answers, fostering durable analytical habits crucial for engineers managing real-time telemetry during emergencies.

Example 4. Low-bandwidth AI writing assistant for project proposals

Intervention. Because nightly drone strikes crippled local fibre links, students drafted feasibility reports offline and then uploaded < 100 KB text snippets to a micro-service (GPT-Lite) hosted on a Raspberry Pi cluster. The tool highlighted jargon density, tone mismatch, and logical gaps.

Outcome. Blind faculty reviewers rated revised drafts 1.2 points higher (on a 10-point scale) for clarity and audience alignment than control-group submissions from the previous academic year. Turnaround time between first draft and final submission shrank by 34 %.

The result confirms that even severely down-scaled AI models can enhance written communication, a finding with direct relevance to universities operating under constrained electricity and internet service.

Across interventions, effect sizes ranged from medium to large, indicating that the proposed AI-supported framework meaningfully accelerates soft-skill acquisition under authentic stressors. Convergent evidence from rubric scores, behavioural analytics, and qualitative self-reports strengthens internal validity, while the use of lightweight, open-source tools enhances external applicability to similarly disrupted educational environments. Collectively, these findings substantiate [11] the article's central claim: artificial intelligence, when ethically and contextually integrated, acts as a catalyst for the rapid development of communication, collaboration, critical thinking, and ethical-digital competencies in wartime higher technical education.

Conclusions

The six-month intervention confirmed that artificial intelligence, when thoughtfully embedded in wartime engineering curricula, can do more than preserve instructional continuity – it can measurably accelerate the growth of the soft-skill suite now essential for Ukraine's recovery and European integration. Chat-bot-mediated negotiations, edge-AI empathy dashboards, deepfake-detection simulations, and low-bandwidth writing assistants each produced statistically significant gains in communication, collaboration, critical thinking, and ethical-digital awareness. Importantly, these gains were achieved under conditions of rolling blackouts, intermittent connectivity, and the psychological strain of ongoing hostilities – conditions that would normally inhibit socio-emotional learning. By externalising metacognitive cues and providing immediate, adaptive feedback, AI acted as a "digital teammate" that scaffolded behaviours difficult for any single lecturer to model consistently during crisis-disrupted semesters.

Equally noteworthy is the portability of the approach: all tools were built on open-source or readily available APIs and optimised for low-bandwidth operation, making them viable for other Ukrainian institutions still operating [12] from temporary

campuses or shelters. Ethical safeguards – data minimisation, end-to-end encryption, and explicit consent protocols – proved compatible with real-time analytics, demonstrating that privacy need not be sacrificed for pedagogical insight. Taken together, the results substantiate the article's central thesis: AI can function as a catalyst for soft-skill advancement in higher technical education, even in the most adverse learning environments.

Prospects for further research

1. Longitudinal impact and transfer to the workplace. Future studies should track graduates into industry placements and post-war reconstruction projects to determine how AI-nurtured soft skills manifest in professional performance and civic engagement.

2. Refinement of multimodal analytics under extreme constraints. Advancing ultra-lightweight models capable of running on battery-powered devices would extend real-time feedback to periods of total power outage, a not-infrequent scenario in frontline regions.

3. Adaptive ethics modules for emerging threats. As generative AI continues to evolve, so too will deepfake sophistication and disinformation tactics. Iterative curriculum design should integrate scenario libraries that reflect the latest threat vectors, ensuring that critical-thinking exercises remain authentic.

4. Scalability across disciplines and cultures. Replicating the framework in non-engineering faculties – medicine, law, humanities – and in other conflict-affected nations would test its generalisability and surface domain-specific adaptations.

5. Co-creation with students and industry partners. Participatory design methods involving learners, faculty, and employers can refine tool affordances and assessment rubrics, aligning them more closely with rapidly shifting labour-market expectations.

By pursuing these avenues, researchers can transform the initial proof of concept into a robust, exportable model for resilient, AI-enhanced education – one capable of equipping future cohorts not only to rebuild Ukraine, but also to thrive in any volatile, uncertain, complex, and ambiguous world they may inherit.

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