

**DIGITAL RESILIENCE IN WARTIME EDUCATION:
THE ROLE OF ONLINE PLATFORMS IN SUSTAINING
ENGLISH LANGUAGE LEARNING**

Nykyporets S. S., Kot S. O., Piddubchak S. Yu.
DOI <https://doi.org/10.30525/978-9934-26-619-5-23>

INTRODUCTION

War tests every seam of an education system. Since 2022, Ukrainian schools and universities have been required to deliver learning under the strain of air-raid alerts, displacement, interrupted timetables, and rolling power cuts. English language teaching has been no exception. In a technical university context, where students must master both academic discourse and the communicative routines of engineering workplaces, the stakes are practical as well as intellectual. This chapter explores how online platforms have been mobilised to sustain English language learning amid these constraints, and how such tools contribute to what I term digital resilience – the capacity of learners, teachers, and institutions to absorb shocks, adapt pedagogy, and continue progressing towards curricular goals.

Digital resilience¹ is not a single technology or a heroic act of endurance. It is a disciplined way of designing courses so that English language learning continues when electricity fails, sirens interrupt, and students move between homes, shelters, and temporary accommodation. In Ukraine since 2022 these are not exceptional conditions but the everyday texture of study. For engineering students the stakes are immediately professional: they must read specifications with care, brief non-specialist stakeholders, file incident reports with precise tense and aspect, and negotiate meaning across international teams. This chapter treats digital resilience as the organising logic of English instruction in a technical university, not as a contingency plan to be opened only during crisis weeks.

¹ Nyakotyo C., Goronga P. Resilience Strategies for Higher Education Institutions. In: Kayyali M. (ed.). *Rebuilding Higher Education Systems Impacted by Crises: Navigating Traumatic Events, Disasters, and More*. IGI Global Scientific Publishing, 2024. P. 1-18. DOI: <https://doi.org/10.4018/979-8-3693-1926-0.ch001>.

By digital resilience we mean the capacity of an educational system to maintain acceptable continuity, equity, and assessment integrity despite shocks, by adapting platforms, practices, and people. Continuity is progression against stated outcomes rather than mere activity. Assessment integrity is the validity of evidence under constraints, achieved through design rather than surveillance. The system spans micro, meso, and macro layers: a student on a low-spec phone downloading an offline packet; a course team mirroring instructions and artefacts across channels; a faculty policy that privileges learning continuity, protects data, and recognises workload.

The Ukrainian context sharpens this question. Rolling blackouts and targeted attacks produce predictable unpredictability. Live seminars drop mid-sentence, upload windows collapse, and attention is fractured by the soundscape of alerts. Under such strain, the platform stack must be layered and redundant. An LMS or VLE anchors structure and assessment; videoconferencing provides social presence when conditions allow; messaging coordinates quickly with light cognitive overhead; content repositories supply stable, versioned materials for offline use; assessment tools gather evidence without multiplying places to check. Every high-bandwidth activity needs a low-bandwidth twin. Every synchronous plan needs an asynchronous mirror with equivalent credit. Privacy-by-design is not a luxury but a safety measure: default settings must minimise exposure of identity and location metadata.

For English language learning in a technical university, resilience translates into concrete pedagogic moves. Communicative practice shifts from generic debates to genres engineers actually use: change logs, incident narratives, concise stakeholder briefs, and clarification emails that reduce ambiguity. Assessment becomes versioned rather than single-shot: draft, feedback, revision, and a short change log that renders learning visible. Integrity is verified lightly through rotating micro-orals that invite students to justify a lexical or structural choice. Open-resource policies authorise dictionaries, corpora, and bounded AI use with disclosure, so the emphasis moves from surveillance to accountable reasoning. Instructors adopt a predictable weekly cadence that reduces decision fatigue: packet release, consolidation, submission, and a grace window during alerts.

1. Sustainability under shocks for resilient English learning

A first strand concerns continuity and equity under constrained infrastructure. Recent open and distance education studies converge on a simple but powerful claim: when platforms and materials are authored for low bandwidth and offline access from the outset, participation stabilises and the gap between well-connected and constrained learners narrows. In an IRRODL study mapping

marginalisation and access across low-resource settings, low-data formats, downloadable bundles, and phone-first design emerged as practical levers for continuity rather than mere accessibility niceties. The findings align with economic evidence² that home broadband availability is a strong predictor of distance-learning engagement, underscoring why tri-channel mirroring and offline-first bundles are not optional in our setting but structural to equity.

The synchronous-versus-asynchronous debate has matured beyond early pandemic polemics. A meta-analysis in IRRODL shows small average differences in outcomes between synchronous and asynchronous formats, with effects moderated by task design and feedback timeliness rather than by live contact per se. A more recent review in medical education similarly reports³ strong satisfaction and learning in both modes when cognitive load is managed and activities are tightly aligned to outcomes. For wartime Ukraine the implication is practical: treat live sessions as a premium commodity for interaction that cannot be replicated, and ensure an equivalent asynchronous path for everything else.

Assessment integrity under disruption is the second major thread. The large Australian multi-institution project led by Bretag⁴ documents a robust relationship between authentic, staged assessment and lower incentives for contract cheating, shifting attention away from heavy remote proctoring towards assessment design that makes authorship visible – drafts, revisions, and criterion-linked change logs. A subsequent systematic review consolidates this evidence and calls for integrity policies that favour transparent process over surveillance, a position that resonates in a security-sensitive environment where cameras and keystroke capture are neither feasible nor ethical during sheltering. These studies give our wartime practice both a vocabulary and an evidence base for versioned tasks and brief oral justifications in lieu of invasive proctoring.

A third body of work deals with the proliferating influence of AI on language learning. A 2024 systematic review⁵ in Smart Learning Environments warns that over-reliance on dialogic AI systems can dampen precisely the

² Sanwal A. Marginalization, technology access, and study approaches of undergraduate distance learners during the COVID-19 pandemic in India. *The International Review of Research in Open and Distributed Learning*. 2024. 25(2). P. 1-19. DOI: <https://doi.org/10.19173/irrodl.v25i2.7718>.

³ Martin F., Sun T., Turk M., Ritzhaupt A. D. A meta-analysis on the effects of synchronous online learning on cognitive and affective educational outcomes. *The International Review of Research in Open and Distributed Learning*. 2021. 22(3). P. 205-242. DOI: <https://doi.org/10.19173/irrodl.v22i3.5263>.

⁴ Bretag T., Harper R., Burton M., Ellis C., Newton P., Rozenberg P., Saddiqui S., van Haeringen K. Contract cheating and assessment design: Exploring the relationship. *Assessment & Evaluation in Higher Education*. 2019. 44(5). P. 676-691. DOI: <https://doi.org/10.1080/02602938.2018.1527892>.

⁵ Zhai C., Wibowo S., Li L. D. The effects of over-reliance on AI dialogue systems on students' cognitive abilities: A systematic review. *Smart Learning Environments*. 2024. 11. 28. DOI: <https://doi.org/10.1186/s40561-024-00316-7>.

cognitive abilities – critical evaluation, analytical reasoning, decision-making – that language courses in technical fields are meant to cultivate. This is not an argument for prohibition but for bounded, transparent use with verification of judgement, a stance consistent with our open-resource policy and short oral checks. The review’s mapping of benefits and risks helps us articulate classroom-level guardrails without pretending that generative tools can be wished away.

Ukraine-specific scholarship has begun to document the distinct texture of teaching and learning under invasion. Studies in Policy Futures in Education and Studies in Higher Education report on quality assurance, care-centred pedagogy, and staff wellbeing, drawing on interviews with academics who taught through curfews and evacuations. A 2025 paper in Higher Education analyses⁶ mechanisms of institutional resilience using student narratives from Lviv, while work on English-medium instruction in a Ukrainian medical university details how EMI lecturers re-engineered discourse routines, materials, and assessment when the campus became a danger zone. Complementary contributions in Romanian and international journals describe practice-level innovations in English teaching – micro-tasks, asynchronous verification, and low-bandwidth scaffolds – and surface the training needs of staff thrust into online instruction by war rather than by institutional strategy. Together these publications move the conversation beyond emergency anecdotes towards a researchable design space for resilient ELT.

A parallel literature on mobile-first and messaging-based learning provides useful, if partial, analogues for our phone-heavy reality. Studies in Education Sciences and IRRODL explore⁷ WhatsApp as a coordination and learning channel in higher education, finding gains in immediacy, group cohesion, and perceived performance when tasks are explicitly structured rather than left to ad hoc chat. These results support our use of pinned weekly checklists and structured prompt types in messaging channels, with the caveat that privacy settings and data jurisdiction must be handled with unusual care in a war context.

Across these strands, unsolved parts of the problem come into focus. First, we still lack causal identification for specific low-bandwidth interventions under real outage profiles. Difference-in-differences and interrupted time-series designs are promising, but they need to be married to high-resolution, ethically

⁶ Błaszczuk M., Kovalisko N., Pieńkowski P., Pachkovskyy Y., Ryniejska-Kieldanowicz M. Coping with adversity: Mechanisms of resilience in Ukrainian universities during the Russian-Ukrainian war – a perspective from Lviv University students. Higher Education. 2025. Advance online publication. DOI: <https://doi.org/10.1007/s10734-025-01506-z>.

⁷ Lee C. E., Chern H. H., Azmir D. A. WhatsApp use in a higher education learning environment: Perspective of students of a Malaysian private university on academic performance and team effectiveness. Education Sciences. 2023. 13(3). 244. DOI: <https://doi.org/10.3390/educsci13030244>.

sourced telemetry on electricity and connectivity to pin down effect sizes in the presence of rolling blackouts. Second, long-term retention in English for Specific Purposes (ESP) under intermittent study remains under-researched: we know more about short-term task performance than about the durability of genre control, technical vocabulary, and pragmatic routines when practice is repeatedly broken. Third, equity has been framed mainly through bandwidth and device access, but Ukrainian displacement patterns, caregiving burdens, disability, and trauma exposure introduce layered disadvantages that current instruments capture only indirectly. Fourth, ethical AI scaffolding⁸ for ESP tasks is still a design hypothesis rather than a tested protocol – we need comparative studies of transparent AI use plus light oral verification against traditional workflows, with attention to voice, bias, and the distribution of benefit across strata. Finally, data protection in occupied or frontline regions is an active risk surface that the mainstream literature scarcely considers, yet the stakes for identity and location exposure are qualitatively different in our context.

Pulling the research threads together, three practice-level regularities stand out. Redundancy and offline-first design associate with higher continuity and smaller equity gaps, not only in low-resource contexts globally but, crucially, in Ukrainian wartime conditions where predictably unpredictable outages turn any single platform into a liability. Assessment flexibility preserves integrity when it is anchored in clear rubrics, staged evidence, and brief oral justification rather than in brittle proctoring. Human presence delivered through short, predictable check-ins stabilises engagement more reliably than long lectures, because cadence and control mitigate cognitive load in a population living with chronic alertness and disruption. These claims are not abstract ideals – they are the places where international findings and Ukrainian experience meet, and they set the agenda for the next round of work.

In sum, the literature already initiates a solution pathway that our practice has begun to follow: configure for graceful degradation, assess for visible judgement, and ritualise humane contact. The research base is young but usable, and it points to a future programme that answers questions Ukraine has made impossible to ignore – what configurations hold under bombardment, for whom, and at what ethical cost.

Conceptual frame and context

Wartime disruption forces language education to survive under power cuts, displacement, and psychological stress, so digital resilience becomes a core educational capacity rather than a bonus. In the Ukrainian higher education

⁸ Nykyporets S. Scaffolding in the foreign language learning process of tertiary education. III International Science Conference on E-Learning and Education. 2021. P. 206-209. DOI: <https://doi.org/10.46299/ISG.2021.I.III>.

sector the issue is not theoretical. Lecturers and students work through rolling blackouts, air raid sirens, curfews, intermittent connectivity, family separation, and the background noise of uncertainty that exacts a cognitive toll. For English language education in a technical university, where communicative competence has immediate professional value, the demand is relentless: reading specifications, drafting incident reports, presenting evidence to mixed expert and non-expert audiences, and negotiating meaning across cultures must continue even when the campus is dark and the timetable is fractured. The conceptual frame that follows treats digital resilience as the organising logic of course design, not a peripheral set of emergency tricks.

By digital resilience we mean the capacity of an educational system to maintain acceptable learning continuity, equity, and assessment integrity despite shocks, by adapting platforms, practices, and people. The definition is deliberately compact but normatively charged. Continuity is not mere activity for activity's sake; it refers to progression against curricular outcomes at a level that stakeholders accept as defensible. Equity is not only access to files but participation with dignity and voice, especially for students whose circumstances are most precarious. The system comprises tools, rules, and relationships: digital services that deliver content and support interaction, institutional policies that set expectations and guardrails, and the human work of teachers and students who translate rules into everyday routines.

To operationalize digital resilience for English learning in a wartime technical university, we propose five interlocking dimensions. First, continuity of access: students can reach core materials, instructions, and submission points regardless of device type, bandwidth, or time zone. In practice this implies mobile-ready pages, text-light versions of resources, downloadable packets for offline study, and mirrored channels so that a single point of failure does not stall a cohort. Second, adaptability of pedagogy: tasks and sequences can pivot between synchronous and asynchronous modes without collapsing their learning intent. A seminar becomes a micro-lecture plus a discussion board with structured prompts; a live presentation becomes a short audio brief with timestamped peer comments. Third, reliability of assessment: evidence can be collected and verified under outages, with clear rubrics, diversified artefacts, and allowances for staged resubmission when interruptions occur. Fourth, equity of participation: course design deliberately counters stratification by bandwidth, device, location, disability, or caregiving load, using low-bandwidth paths, flexible deadlines, and peer structures that prevent the quiet disappearance of vulnerable learners. Fifth, data protection for vulnerable learners: platforms and workflows minimise exposure to surveillance, harassment, or secondary harms, with careful handling of identities, locations, and personal artefacts.

Together these dimensions make resilience measurable and actionable at course level.

The wartime constraint set is concrete and persistent. Rolling blackouts destabilise scheduled sessions and erase the assumption that learning can be anchored to a fixed time grid. Connectivity loss is uneven across neighbourhoods and hours, producing asymmetric participation even within the same class. Mobility and safety restrictions make commuting hazardous or impossible; temporary shelter may lack quiet space for study. Air raid interruptions halt synchronous meetings on minutes' notice and force abrupt transitions between cognitive tasks and protective action. Device scarcity means siblings and parents share one laptop or rely on ageing phones with limited storage. Cybersecurity threats rise as phishing, spoofed update prompts, and misinformation target stressed populations; a hasty click can compromise personal data or institutional systems. Cognitive load is amplified by ambient anxiety, fragmented sleep, and the mental overhead of contingency planning. Each constraint translates into design requirements. For example, if power cuts are predictable in windows, the course must support time shifting; if connectivity is fragile, audio-first options must exist for activities commonly designed around video; if devices are shared, file sizes and storage footprints must be kept low.

Against this constraint field, the platform stack functions as a layered infrastructure rather than a silver bullet. A learning management system or virtual learning environment provides structure: a canonical syllabus, week-by-week modules, instructions, and a gradebook that anchors expectations. Videoconferencing sustains synchronous contact and social presence, but must be treated as a luxury mode rather than the default, with automatic recording for later access and explicit backup plans. Messaging platforms handle lightweight coordination: urgent alerts, quick polls, and clarifications when other channels fail. Content repositories serve as stable, versioned stores where students can download readings, slide decks, exemplars, and task sheets for offline use. Assessment tools collect evidence, maintain rubrics, and manage resubmissions without multiplying places to check. AI assistants operate as scaffolding, offering language reformulations, genre-aware prompts, or formative feedback that shortens revision cycles. Crucially, the stack must be configured for redundancy and low-bandwidth paths. Every high-bandwidth interaction should have a text or audio analogue; every synchronous moment should have an asynchronous mirror with clear deadlines and equivalent credit.

Two guiding research questions (RQ) orient the empirical and design claims of this chapter.

RQ1: Which platform features most strongly predict continuity and outcomes under outages.

RQ2: Which low-bandwidth and offline strategies mitigate inequity. On the basis of prior practice and the constraint analysis above, we advance the following hypothesis.

H1: Redundancy and offline-first design correlate with higher continuity and more stable outcomes. Redundancy here refers to mirrored channels and duplicated affordances that permit learning to proceed when one tool or mode fails; offline-first describes the practice of designing materials and tasks so that the default assumption is intermittent connectivity.

To make these questions tractable, the conceptual frame translates features and strategies into testable units. Candidate features likely to predict continuity include automated capture of synchronous sessions with privacy-aware access controls, in-platform low-data commenting that functions reliably on older phones, one-click content packaging for offline use, and graded discussion workflows that award partial credit for alternative formats. Candidate strategies for mitigating inequity include audio diaries instead of video submissions, strict page and file size budgets for readings and slides, rubric-aligned checklists to reduce ambiguity, and scheduled downtime that respects known blackout windows in different regions. These units can be coded at course level and linked to participation traces and outcome indicators such as timely submission rates, revision depth, and rubric stability across cohorts.

The conceptual frame also clarifies the roles and risks of AI assistants within a resilient ecology. As scaffolds, they can surface grammar patterns, propose pragmatic rephrasings for technical reporting, and generate formative prompts for peer review. As risks, they may flatten rhetorical voice, blur authorship boundaries, and create over-reliance that masks fragile underlying competence. A resilience lens requires transparency about tool use, explicit boundaries in task design, and meta-linguistic reflection that trains students to interrogate outputs rather than outsource judgement. The goal is to protect assessment validity while harnessing AI's value for practice and feedback in constrained conditions.

Policy and governance form the institutional envelope around the stack. Attendance policies must acknowledge that presence can be documented through artefacts, not only through punctuality on a video call. Assessment boards should accept structured resubmission after outages and guide programmes towards diversified evidence rather than single high-stakes events. Privacy policies must constrain the circulation of recordings and student artefacts, especially where location data could increase personal risk. Staff workload models should recognise the labour of maintaining mirrored paths and templates, with departmental repositories that prevent duplication and drift. Without this governance layer, even well-chosen platforms will underperform,

because rules and incentives will pull teachers back towards fragile, high-bandwidth default practices.

In the Ukrainian context, the human element is decisive. Teachers curate, translate, and choreograph the ecosystem so that students can progress during disruption. Students sustain peer networks that carry information and morale across outages. Both groups must cultivate platform literacy: understanding default settings, data jurisdictions, and the subtle ways in which interface design shapes attention and interaction. In English courses this literacy is not ancillary but curricular, because the language of platforms is itself a communicative genre that students will navigate in their professional lives. Teaching students to read a dashboard, challenge a recommendation order, or choose a privacy setting is simultaneously language practice and digital citizenship.

This conceptual frame supports a clear argument⁹ arc for the chapter. Platforms enable continuity only when configured with redundancy, low-bandwidth paths, and assessment flexibility shaped for wartime realities. Resilience emerges from alignment: constraints are mapped with precision, the stack is layered accordingly, pedagogy is designed to travel between modes without losing intent, and policy protects equity and integrity. When any link in that chain is weak, the system fails in predictable ways, and the most vulnerable students pay the highest price.

The next paragraph operationalizes these constructs into measurable indicators, describes the empirical setting in a Ukrainian technical university, and presents initial evidence on how specific platform features and offline-first strategies relate to participation patterns, submission continuity, and assessment stability under blackout conditions.

Evidence, methods, and mechanisms in action

This section pivots from concepts to evidence by showing how specific platform configurations sustained English learning for engineering students during wartime, and by unpacking the mechanisms through which those configurations worked. The account draws on a mixed body of data generated in Vinnytsia national technical university between autumn 2022 and spring 2025, a period marked by rolling blackouts, air raid interruptions, curfews, and recurrent connectivity loss. Rather than seeking a single decisive experiment, the analysis triangulates platform analytics, course artefacts, and brief surveys with instructor reflections to identify design patterns that held up under pressure.

⁹ Nykyporets S. S., Boiko Y. V. Practical tips and interactive learning tools for the work of a foreign language teacher at a technical university in the conditions of blended learning during the full-scale military aggression of Russia against Ukraine. World trends in the use of interactive technologies in education: International collective monograph. Chap. 14. Intelligence Transportation System and Smart City Institute (ITSSCI), 2024. P. 322-348. DOI: <https://doi.org/10.5281/zenodo.10653715>.

The guiding claim is simple but testable: platforms enable continuity only when configured with redundancy, low-bandwidth paths, and assessment flexibility, and when these choices are made explicit to teachers and students.

Data landscape and sources

Four complementary streams of evidence underpin the analysis.

First, platform analytics and LMS logs provided session-level traces of attendance, submissions, and time-on-task. For each cohort, the LMS recorded page views by resource, quiz and assignment submission time stamps, forum posts, and access device type where available. Videoconferencing metadata supplied counts of attendees per synchronous session and the duration of participation per user. Messaging platforms contributed only coarse metrics by design, but we captured posting frequency and the proportion of instructor versus student-initiated messages.

Second, course gradebooks and standardised task rubrics provided outcomes. Each English for Engineering module used four common task families across terms: technical reading briefs, incident-report writing, short oral briefs, and a capstone integrative memo addressed to a non-specialist stakeholder. Rubrics were criterion-referenced and invariant across terms with minor wording clarifications, allowing comparison within and between cohorts.

Third, short pulse surveys of students and instructors captured access constraints and perceived efficacy. Student surveys, administered at three points in each term, asked about electricity and connectivity availability during the previous fortnight, device type and sharing, perceived cognitive load, and the helpfulness of specific platform features. Instructor surveys focused on workload, friction points, and perceived reliability of mirrored workflows. To keep response burden low, each survey took fewer than five minutes.

Fourth, instructor reflection notes and brief interviews supplied qualitative accounts of mechanisms. Instructors maintained weekly reflection notes for internal moderation, responding to prompts about what failed, what worked, and what was modified mid-course. A subset participated in 20-30 minute interviews at term end to elaborate on strategies and perceived trade-offs.

The combined dataset is pragmatic rather than pristine. Logs are occasionally incomplete due to outages; surveys contain self-report bias; reflections are subject to hindsight. Yet the triangulation of traces, artefacts, and first-hand accounts offers enough structure to answer the guiding questions with appropriate caution.

Measures and operationalization

To link configurations to effects, four indices are defined in-line.

1. Continuity index. The proportion of scheduled sessions that were successfully converted into learning events per week despite disruptions.

A learning event is counted¹⁰ when students receive an instruction and a practicable route to complete the associated task synchronously or asynchronously within the week, and at least 60 percent of enrolled students access the event artefact. The numerator aggregates completed live sessions, posted micro-lectures with guided tasks, and documented asynchronous fallbacks; the denominator is the planned session count. The index ranges from 0 to 1 and is computed weekly, then averaged per term.

2. Engagement stability. The variance of attendance and submission rates across outage windows. We segment the term into blackout weeks and relatively stable weeks using local electricity provider outage schedules and aggregated student reports. Engagement stability is defined¹¹ as 1 minus the normalised variance of attendance and on-time submission rates across those segments, so higher values indicate steadier engagement despite volatility.

3. Outcome robustness. The stability of performance on common tasks across terms adjusted for exposure to outages. For each rubric criterion we compute z-scores within term and then estimate the absolute difference between cohort means across adjacent terms, adjusting for the mean blackout hours reported by the cohort via a linear covariate. Lower adjusted differences indicate more robust outcomes.

4. Equity gap. The difference in continuity and outcomes across device-bandwidth strata. Students are binned into three strata based on self-report and logs: high bandwidth laptop or desktop primary use, mid bandwidth smartphone primary use, and constrained access defined by shared device or frequent offline study. Equity gap is the absolute difference in continuity index reach and in rubric totals between the most advantaged and most constrained bins.

These indices are not perfect, but together they allow us to test whether mirrored, low-bandwidth, and flexible assessment designs cushion cohorts against the shock of outages, and whether they do so without widening disadvantage.

Three design choices structure the analysis.

1. Mixed-methods linkage. We link log-derived indices to survey indicators and to coded instructor reflections at the module-week level. The linkage is anonymized and uses cohort-level aggregates to avoid re-identification. This

¹⁰ Kot S. O., Nykyporets S. S. Activating students' cognitive engagement in technical English learning with AI tools. Science and education in the third millennium: Information technology, education, law, psychology, social security and work, management. International collective monograph. Vol. I. Lublin: Institute of Public Administration Affairs, 2025. P. 295-332. DOI: <https://doi.org/10.5281/zenodo.16942267>.

¹¹ Nykyporets S. S. Harnessing cloud technologies for foreign language acquisition among masters in energy engineering. Moderní aspekty vědy: Svazek XXXI mezinárodní: Kolektivní monografie. 2023. P. 21-56. URL: <http://perspectives.pp.ua/public/site/mono/mono-31.pdf>.

alignment lets us match observed stabilisation in engagement to reported use of low-bandwidth artefacts or mirrored repositories, and to instructors' accounts of what they changed.

2. Quasi-experimental contrasts. We compare blackout weeks to relatively stable weeks within the same term for the same cohort, and we compare terms that deployed specific interventions to immediately prior terms that did not. The first comparison addresses short-run resilience under shock; the second addresses medium-run effect of design choices.

3. Simple difference-in-differences and interrupted time series. For interventions introduced mid-term, such as a switch to compressed audio summaries plus transcripts, we use interrupted time series with a two-week pre and four-week post window to estimate level and slope changes in attendance and submission rates. For interventions adopted between terms, such as offline-first content packages, we estimate a difference-in-differences model with cohort and week fixed effects. Given the modest scale and the non-random nature of adoption, estimates are treated as suggestive rather than causal proof.

4. Instructor strategy coding. Reflection notes and interviews are coded thematically around friction-reduction strategies. Codes include redundancy, low-bandwidth defaults, asynchronous fallbacks, assessment resilience, and wellbeing scaffolds, with sub-codes for concrete tactics like pinned message checklists, versioned templates, audio-first briefs, or rubric-linked comment banks. Co-coding by two researchers produced acceptable agreement, with disagreements resolved through discussion.

Five mechanisms recur across the logs and narratives. Each is illustrated with brief examples and linked to movements in the indices.

1. Redundancy: mirror materials on LMS, cloud drive, and messaging pins.

When slides, task sheets, and exemplars were posted to the LMS module page, mirrored to a cloud drive folder structured by week, and pinned in the cohort messaging channel, the odds that at least 60 percent of students accessed the artefact within 48 hours rose sharply during blackout weeks. In one term, moving from single-location posting to tri-channel mirroring mid-course produced a visible step change in the Continuity Index, from a blackout-week mean of 0.67 to 0.86 in the four weeks after the change. Instructor reflections explain the gain: students who could not authenticate to the LMS during brief uplinks could still fetch the drive folder via a shared link, and those who worked primarily in messaging apps had the pinned checklist as a lightweight point of reference. The redundancy also reduced instructor follow-up, with fewer one-to-one requests for lost links reported in messaging logs.

2. Low-bandwidth defaults: slide decks plus transcripts and compressed audio.

Replacing live-heavy sessions with micro-lectures delivered as 8-12 slide decks, each slide captioned with a short transcript and accompanied by a 3-5 minute compressed audio brief, stabilised engagement in weeks of frequent sirens. Attendance to live calls fell as expected, but on-time submission rates remained high, and engagement stability improved. In an interrupted time series around the switch, the level of on-time submission increased by 7-10 percentage points in blackout weeks while remaining flat in stable weeks, suggesting that the low-bandwidth default cushioned the shock without inflating activity in already stable conditions. Students in the constrained stratum reported that audio briefs downloaded quickly enough during short connectivity windows and could be replayed offline, allowing them to control cognitive load when anxiety spiked after sirens.

3. Asynchronous fallbacks: deadline windows, microtasks, and forum threads when live sessions drop. Where courses specified an asynchronous mirror for every live session at the start of term, with a clear deadline window (for example 72 hours), a microtask equivalent to the live activity, and a structured forum thread with two prompt types (explain and challenge), continuity index values in blackout weeks approached stable-week values. In one cohort the difference narrowed to less than 0.05 on average. Importantly, the gain did not come entirely from students who missed the live call; a non-trivial subset of live attendees posted follow-up microtasks during the window, which instructors described as consolidation. Reflection notes describe a workable pattern: a live vocabulary-in-context activity around an incident report is mirrored by a short reading with a targeted lexicon extraction microtask and a forum prompt asking students to propose two alternative phrasings that reduce ambiguity for non-specialist readers. The fallbacks were not an afterthought; they were designed in tandem with live plans, which made the pivot smoother when calls dropped.

4. Assessment resilience: versioned tasks, oral checks with recording, open-resource integrity policies. Assessment designs that foregrounded versioning and authentic artefacts were measurably more robust. When the capstone memo was split into two versions, a draft and a revised submission with a short change log, outcome robustness improved term-on-term despite greater blackout exposure. The change log, a 150-200 word note explaining revisions against rubric criteria, served as a metacognitive checkpoint and a deterrent to wholesale ghostwriting. In addition, instructors scheduled brief oral checks, 3-4 minutes per student, using low-data audio calls or recorded voice messages, to verify authorship for high-stakes tasks. Students were informed at the start of term that English was being assessed in an open-resource regime: use of

dictionaries, corpora, or AI assistants was permitted within declared bounds, but students must be able to justify lexical and structural choices in a short oral exchange. Logs show that after the introduction of oral checks and open-resource transparency, the rate of last-minute file resubmissions during blackout spikes declined, and rubric stability increased. Instructors reported fewer integrity disputes and more targeted feedback conversations.

5. Wellbeing scaffolds: predictable cadence and lighter cognitive load during alerts. Courses that adopted a predictable weekly cadence reduced decision fatigue. The pattern was simple: Monday micro-lecture packet release, midweek forum consolidation, Friday submission, with a no-penalty 48 hour grace window in blackout weeks. Messaging channels carried a weekly pinned checklist and a short summary of the week's goals in plain language. During heightened alert periods, instructors pre-announced lighter cognitive load weeks, swapping dense readings for executive summaries and reducing the number of sub-tasks while preserving the core skill focus. Survey responses link this scaffolding¹² to perceived control. Engagement stability increased when cadence was predictable, and equity gaps in both access and outcomes narrowed because constrained students could plan scarce electricity windows around known release times.

Two contrasts are especially instructive. Low-bandwidth intervention difference-in-differences: one module introduced compressed audio briefs plus transcripts between Term A and Term B, holding rubrics and task families constant. In blackout weeks, on-time submission rates increased by an average of 9 percentage points in Term B relative to Term A, while stable-week submissions did not change significantly. The difference-in-differences estimate suggests that the gain was linked to the low-bandwidth intervention rather than to cohort idiosyncrasies. The continuity index also rose in blackout weeks from 0.72 to 0.88 on average. Qualitative notes attribute the effect to students banking audio during short connectivity windows and to instructors writing tighter prompts.

Offline-first content packaging interrupted time series: mid-term in Term C, instructors began posting weekly offline bundles comprising slide decks, transcripts, task sheets, and model answers from prior years in a single compressed file under 20 MB. The interrupted time series shows a level shift in artefact access within 48 hours of release and a decline in messaging requests for lost links. The engagement stability index improved in the four weeks after

¹² Stepanova I. S., Nykyporets S. S., Ibrahimova L. V., Hadaichuk N. M., Herasymenko N. V. Challenges and strategies for professional development of English language teachers in war-affected regions. *Grail of Science: International Scientific Journal*. 2025. 50. P. 677-684. DOI: <https://doi.org/10.36074/grail-of-science.21.03.2025.087>.

the change, with variance narrowing most sharply for the constrained stratum. Instructors noted that the bundle acted as a shared anchor during multi-day outages, reducing the need for ad hoc redistribution.

Equity gap trends are mixed but instructive. Before mirrored repositories and offline bundles, the gap in continuity index reach between the advantaged and constrained strata routinely exceeded 0.20 in blackout weeks. After adoption, the gap narrowed to 0.08-0.12 in most cohorts, though it rarely vanished. Outcome equity gaps, measured by rubric totals, were smaller to begin with but still present, typically 3-5 percent of the total rubric points. Versioned assessments plus oral checks narrowed this gap by about 1-2 percentage points, especially in writing tasks where constrained students could leverage offline time for revision without losing credit because they missed a live drafting activity. It bears emphasising that equity is as much about predictability as it is about bandwidth. Surveys reveal that students with shared devices benefited disproportionately from fixed release times and clear fallback windows, which allowed them to negotiate device access at home.

Friction reduction and instructor workload

Digital resilience that lasts across terms requires friction reduction for staff. Reflection coding highlights four friction points and associated mitigations.

Link entropy. With materials scattered across LMS pages, drives, and messaging threads, both students and instructors lost time locating the latest version. Weekly checklists pinned in messaging with canonical links and a standard naming convention reduced entropy. Versioned file names with timestamps and a simple trailing v1 or v2 prevented accidental grading of old drafts.

Feedback overhead. High-stakes single-shot submissions created grading spikes that were hard to absorb during outages. Splitting tasks into draft plus revision spread workload and made feedback more targeted. Rubric-linked comment banks in the LMS allowed instructors to paste criterion-level comments quickly while retaining space for personalised notes.

Synchronous over-dependence. When courses leaned heavily on live sessions, cancellations created cascades of rescheduling. The explicit design of asynchronous mirrors with pre-written prompts removed the need for ad hoc substitutes. Surveys show¹³ that instructors initially feared loss of social presence, but audio replies and targeted peer comments maintained enough interaction to prevent disengagement.

Security and privacy uncertainty. Instructors were unsure which platform settings protected student identity or location data. Departmental templates

¹³ Cilligol Karabey S., Karaman S. Identifying pedagogical design and implementation of synchronous virtual classrooms. The International Review of Research in Open and Distributed Learning. 2024. 25(2). P. 132-154. DOI: <https://doi.org/10.19173/irrodl.v25i2.7584>.

with pre-configured privacy defaults and a one-page checklist reduced risk and decision fatigue.

A tight ethical and security note is warranted: protect student identity and location data, minimise surveillance, and avoid exposing sensitive metadata by default.

Linking mechanisms to indices

Across modules and terms, the mechanisms align with index movements in consistent ways. Redundancy lifts the continuity index because more students can access artefacts promptly through at least one channel; low-bandwidth defaults dampen variance in attendance and submission, raising engagement stability; assessment resilience designs reduce outcome robustness fluctuations by preserving validity under shock; and predictable cadence plus offline-first bundles narrow equity gaps by giving constrained learners workable paths. The data do not show that any single mechanism is sufficient. Gains are largest when two or more mechanisms are present together, especially redundancy paired with low-bandwidth defaults, and assessment resilience paired with wellbeing scaffolds.

Three cautions temper the claims. First, despite difference-in-differences and interrupted time series, the evaluation is not a randomised trial. Cohort composition, instructor experience, and local infrastructure improvements could confound effects¹⁴. Second, indices compress complex realities. A high continuity index does not guarantee depth of learning; a stable engagement trace can coexist with quiet fatigue. Third, equity requires a lens beyond bandwidth. Disability accommodations, caregiving duties, and trauma exposure shape participation in ways the current instruments only partially capture. We report what the data can sustain and flag where richer methods are needed.

To ground the abstractions, three short vignettes illustrate mechanisms at work.

Vocabulary for safety-critical instructions. A live session on writing clear safety notices was interrupted twice by sirens. Because the week had a predefined mirror, students pivoted to an asynchronous packet with paired examples and a microtask to rewrite ambiguous sentences. A 4 minute audio brief explained why imperatives with poor deictic anchoring fail in shelters. Submissions remained high and peer feedback focused on deictic precision. The continuity index for the week did not dip, and instructor notes emphasised that the mirror preserved the pedagogic intent, not just activity.

¹⁴ Espinosa Andrade A., Padilla L., Carrington S. J. Educational spaces: The relation between school infrastructure and learning outcomes. *Heliyon*. 2024. 10(19). e38361. DOI: <https://doi.org/10.1016/j.heliyon.2024.e38361>.

Incident-report writing under blackout. In a week with scheduled 6 hour evening blackouts, the instructor released a compressed offline bundle with annotated exemplars and a checklist for tense and aspect in procedural recounting. Students drafted offline and uploaded the next morning. Rubric-linked comment banks accelerated feedback, and a brief oral check the following week verified authorship. Outcome robustness remained within the prior term's band despite heavier outages, and students in the constrained stratum performed on par with the cohort median.

Capstone memo with versioning and open resources. The capstone required synthesising technical findings for a non-specialist bank stakeholder. Students submitted a draft, received criterion-level comments, and resubmitted with a change log. They were authorised to consult corpora and AI assistants within declared limits. Oral checks asked each student to defend two lexical choices and one structural choice. Integrity disputes fell to near zero. Instructors reported¹⁵ a higher signal-to-noise ratio in feedback conversations, and the equity gap in rubric totals narrowed by just over one percentage point.

The mechanism lens explains¹⁶ why superficially similar courses fared differently. Courses that used the same LMS and videoconferencing platform diverged in continuity index and engagement stability because one configured redundancy and mirrors while the other relied on live sessions with ad hoc substitutions. Courses that both adopted AI assistants diverged in outcome robustness because one embedded transparency and oral checks, while the other treated AI use as a taboo, driving it underground and distorting the feedback loop. Courses that both posted readings diverged in equity gaps because one enforced strict file size budgets with transcripts and summaries, while the other uploaded large image-heavy PDFs that were unusable on shared phones.

Practical implications for course teams

Five design moves emerge as low-cost, high-gain.

Set mirroring as policy, not preference. Make tri-channel posting the default through templates and staff induction. The marginal effort is small once naming conventions and checklists are in place.

Author content for audio-first. Write micro-lecture scripts for reading aloud, keep clips short, attach transcripts, and compress files. Encourage students to bank audio during connectivity windows.

¹⁵ Jones D., Murray N. The impact of the Russia-Ukraine war on English-medium instruction teachers' professional identity in a Ukrainian medical university. *International Journal of Educational Development*. 2025. 116. 103315. DOI: <https://doi.org/10.1016/j.ijedudev.2025.103315>.

¹⁶ Lancaster T., Cotarlan C. Contract cheating by STEM students through a file sharing website: A Covid-19 pandemic perspective. *International Journal for Educational Integrity*. 2021. 17. 3. DOI: <https://doi.org/10.1007/s40979-021-00070-0>.

Design fallbacks with parity. Specify asynchronous mirrors in advance and award equivalent credit. Provide prompts that drive higher order moves – explanation and challenge – so mirrors are not busywork.

Assess in versions and verify lightly. Split high-stakes tasks, require change logs, and conduct brief oral checks. Publish an open-resource integrity policy that sets clear, bounded expectations.

Anchor the week and lighten load under alerts. Fix release times, pin checklists, honour grace windows during outages, and explicitly reduce cognitive load when sirens are frequent.

None of these moves depends¹⁷ on a particular brand of platform. They depend on configuration discipline and shared habits.

Taken together, redundancy, low-bandwidth defaults, asynchronous fallbacks, assessment resilience, and wellbeing scaffolds act on the indices in predictable ways: they raise the continuity index, dampen variance to increase engagement stability, reduce cross-term fluctuations to strengthen outcome robustness, and narrow the equity gap by ensuring constrained learners can participate with dignity.

2. Findings synthesis, implications, and a practical wartime workbook

This section distils what works, where it tends to fail, and how to institutionalise the gains for English instruction in technical universities under wartime conditions. The synthesis is anchored¹⁸ in the Ukrainian experience of teaching under air-raid alerts, rolling blackouts, displacement, and the ever-present cognitive drag of uncertainty. The headline is clear enough to carry into policy: English learning for engineers does not survive on goodwill or heroic improvisation alone – it survives when platforms, pedagogy, and policy are deliberately engineered for redundancy, offline-first access, assessment flexibility, and humane, predictable contact. Where these design choices were implemented with discipline, continuity rose and inequity narrowed; where they were absent or applied inconsistently, participation fractured along the fault lines of bandwidth, device, and geography.

The first consolidated finding concerns redundancy and offline-first design. When materials, tasks, and announcements were mirrored across a canonical LMS page, a structured cloud repository, and pinned messaging posts, students were able to reach what they needed through at least one channel during short

¹⁷ Meng W., Yu L., Liu C., Pan N., Pang X., Zhu Y. A systematic review of the effectiveness of online learning in higher education during the COVID-19 pandemic period. *Frontiers in Education*. 2023. 8. 1334153. DOI: <https://doi.org/10.3389/educ.2023.1334153>.

¹⁸ Zayachuk Y. Ensuring quality higher education in Ukraine in times of war. *Journal of Adult and Continuing Education*. 2025. 31(1). P. 135-159. DOI: <https://doi.org/10.1177/14779714241270254>.

connectivity windows. Low-bandwidth defaults – transcripts before video, compressed audio briefs before long live lectures, text-light versions of slide decks – decoupled learning from the volatility of the grid. The effect was not cosmetic. Week by week, cohorts that worked within mirrored, offline-ready ecosystems converted a higher proportion of planned sessions into actual learning events and displayed smaller swings in attendance and timely submission during outage-heavy periods. Equally important, the equity gap between students with private laptops and stable connectivity and those sharing devices or working mostly on phones shrank to a tolerable band. In the language of engineering, redundancy and offline-first did what they are supposed to do: they removed single points of failure, and they placed graceful degradation at the heart of the system.

The second finding speaks to assessment. Flexibility preserved integrity rather than diluting it, provided rubrics were explicit and evidence types were intentionally diversified. Splitting high-stakes tasks into draft-plus-revision with short change logs created a transparent trail of learning and reduced the temptation to outsource authorship. Oral verification of authorship, conducted via brief low-data calls or recorded voice notes, was less intrusive than proctoring and more respectful of safety constraints in shelters. Declaring open-resource conditions – authorising dictionaries, corpora, and bounded use of AI scaffolds with clear disclosure – shifted the emphasis from surveillance to justification, which is where engineers live professionally. Grades did not inflate. Instead, criterion-level stability improved because tutors could focus feedback on observable decisions in language and structure, and students could demonstrate the reasoning behind those decisions even when their upload time was a five-minute window between sirens.

The third finding is human and deceptively simple: short, predictable check-ins stabilised engagement more effectively than long live lectures. A weekly cadence – release of a micro-lecture packet on Monday, a forum consolidation midweek, a submission on Friday with a no-penalty 48-72 hour grace window during alerts – allowed students to plan scarce electricity and device time. Rotating micro-orals, two to four minutes per student over the term, created a sense of presence without imposing the cognitive and infrastructural burden of extended conferencing. Instructors described the difference with an analogy we all recognise now in Ukraine: when the power company publishes outage schedules, households cope; when it does not, each day is a small emergency. Pedagogy behaved in the same way.

The synthesis also has edges where practice failed or under-delivered. Where courses continued to privilege live sessions as the unmarked default and treated asynchronous mirrors as a last-minute patch, continuity index values

dipped sharply whenever alerts clustered. Where materials were posted¹⁹ as large image-heavy PDFs without transcripts or text-first alternatives, phone-reliant students were excluded in practice even if not in policy. Where integrity policies leaned on heavy proctoring or opaque tools, trust eroded and teacher workload spiked, with little evidence that cheating fell. The moral is not to abandon synchronous teaching or integrity concerns, but to reframe them under wartime constraints: live contact is a premium commodity to be spent sparingly on interaction that cannot be replicated offline; integrity must be protected with methods that travel across bandwidth and shelter walls.

Turning from synthesis to practice, a compact implementation blueprint can be narrated for departments seeking to institutionalise these gains. Platform configuration comes first, not because the brand matters, but because defaults matter. Set the LMS or VLE to render low-bandwidth views by default and to surface transcript-first resources at the top of each module page. Enable offline download for readings, slide decks, transcripts, and task sheets, and compress bundles so they remain accessible on older phones with limited storage. Pre-publish all links for the week in a single canonical place on the LMS, then mirror that weekly bundle in a cloud folder with a stable naming convention and pin a checklist in the cohort messaging channel that repeats those links in plain language. Treat tri-channel mirroring as policy rather than instructor preference. Configure videoconferencing so that recordings are automatic when safety allows and permissions default to cohort-only access with expiry dates. None of this is flashy, but each setting reduces friction when people are trying to learn by torchlight.

Teaching routines then give those platforms a rhythm. Announce dual-path activities at the start of each week, making the asynchronous mirror visible before the first live session begins. Keep submission windows open for at least 72 hours in periods of frequent alerts so that students can thread their work through outage schedules. Provide transcript-first resources consistently, with short audio briefs that can be banked during brief uplinks, and design live sessions so that the core cognitive move – analysis, reformulation, justification – can be completed in the mirror task if the call collapses. Rotate micro-orals for verification and connection, planning two or three minutes per student rather than attempting long group seminars that collapse under uncertain bandwidth. Use rubric-linked comment banks to keep feedback specific and sustainable; reserve truly bespoke commentary for misconceptions or exemplary moves.

¹⁹ Romero-Saritamá J. M., Durán-Aguilar R. J., Robles-Molina L. L., Rivera-Lombardi A., Inga-Berrocá E. Using WhatsApp in distance education: Assessing the impact on students' outcomes and behaviours. *Social Sciences*. 2025. 14(3). 183. DOI: <https://doi.org/10.3390/socsci14030183>.

Assessment policy codifies the integrity of this routine. Write for outcome equivalence across formats by specifying what counts as acceptable evidence of a learning objective whether produced live, offline, or through a hybrid route. Require version control for major tasks – draft, feedback, revision, and a short change log – so that learning is visible and feedback is actionable. Replace surveillance with verification that respects safety constraints: short oral defences of lexical and structural choices, transparent declarations of resource use, and, where appropriate, randomised task variants drawn from the same difficulty pool. By stating openly that dictionaries, corpora, and limited AI scaffolds are permitted within declared bounds, and by requiring students to justify their choices, we align the classroom with the communicative realities of engineering – where tools are used, but judgement is accountable.

Equity safeguards sit alongside these policies as explicit design constraints. For every activity, provide a device-light alternative that can be completed on a phone with intermittent connectivity, and keep the file size budget tight. When the situation demands it, use paper bundles distributed through safe campus points or municipal libraries, and accept SMS or low-data messaging for short submissions or check-ins. Coordinate with faculty or donor programmes to target loaner devices and power banks to students who self-identify as constrained; even a small pool can dramatically reduce attrition in the most vulnerable stratum. Remember that equity is not simply access to files – it is the ability to participate with dignity and predictable expectations.

Alongside the blueprint, we should name the risks in crisp, operational terms. Single-point-of-failure platforms create brittle systems – if everything depends on a single service, a routine outage becomes a pedagogic crisis. Data privacy pitfalls multiply under stress – poorly configured sharing exposes identities and locations, and recording by default without expiry bakes surveillance into the course. Overreliance on AI scaffolds can flatten voice and hide fragile competence – without transparent boundaries and light-touch oral verification, tools that were meant to scaffold become tools that supplant. Staff burnout is a real operational risk – mirroring and feedback routines demand upfront labour, and without departmental templates, protected time, and mutual aid, the system will run on fumes.

A question naturally arises about generalizability. Some elements of this playbook are distinctly Ukrainian, shaped by the scale and cadence of grid attacks, the routine of air-raid alerts, and the specific mix of mobile networks, generators, and community resilience we have developed. The habit of designing for predictable unpredictability – keeping 72-hour windows, pre-publishing mirrors, templating oral verifications to fit around curfews – bears the stamp of our context. Yet the core principles travel to other crisis settings: redundancy

to remove brittle dependencies, offline-first to honour the reality of intermittent connectivity, assessment flexibility to preserve validity when proctoring is neither feasible nor ethical, and humane cadence to maintain a sense of control. Whether the crisis is a natural disaster, political unrest, or an infrastructure failure, these are not Ukrainian tricks – they are general properties of resilient instructional systems.

Looking forward, three lines of research are urgent and feasible. First, we need causal estimation with richer outage telemetry – linking anonymized, high-resolution electricity and connectivity data to course traces to isolate the marginal effect of specific low-bandwidth interventions under real shock profiles. Second, we should track long-term language retention under intermittent study – not just immediate task performance, but the durability of vocabulary, genre control, and pragmatic competence when learning proceeds in starts and stops over months. Third, we must design and evaluate ethical AI scaffolding for English for Specific Purposes tasks – prompts, guardrails, and verification routines that amplify practice without displacing judgement, with special attention to transparency, bias, and the equitable distribution of benefit.

The result of this synthesis is a wartime playbook that is both modest and robust. It does not promise that learning will feel effortless – nothing does under bombardment – but it shows how to make English instruction for engineers survivable and fair. Institutionalise tri-channel mirroring and offline bundles; cadence the week so that students can plan around darkness; treat live contact as a precious resource measured in minutes; write assessments that travel across formats and leave an audit trail of reasoning; verify lightly but consistently; protect data like a safety-critical asset; and direct scarce support to those who would otherwise fall out of view. None of these moves depends on new money or new platforms so much as on shared discipline, clear templates, and the recognition that resilience is not a mood but a design property.

CONCLUSIONS

Digital resilience is the capacity of an educational system to maintain acceptable learning continuity, equity, and assessment integrity despite shocks, by adapting platforms, practices, and people – it is not a feature toggle, and when we engineer it into our platforms, pedagogy, and policy, it keeps English learning alive precisely when everything else is failing.

This article has argued that in wartime Ukraine English language education survives not by accident but by design. Digital resilience – the capacity to maintain acceptable continuity, equity, and assessment integrity despite shocks – is built when platforms, pedagogy, and policy are engineered to absorb disruption rather than deny it. The evidence from technical university

cohorts points in the same direction across terms: redundancy and offline-first choices raise continuity and shrink equity gaps; assessment flexibility preserves validity without inflating grades; short, predictable human check-ins stabilise engagement better than long, brittle live lectures. In plain terms, the system works when every high-bandwidth experience has a low-bandwidth twin, when every synchronous plan has an asynchronous mirror, and when integrity is demonstrated through transparent process rather than enforced through fragile surveillance.

The practical implications are modest and powerful. Configure the platform stack for graceful degradation – transcript-first views, compressed audio, offline bundles, tri-channel mirroring as a rule not a favour. Design teaching for dual paths – 72 hour windows, forum prompts that demand explanation and challenge, rotating micro-orals for verification and contact. Write assessment for outcome equivalence across formats, with drafts, revisions, and change logs that reveal thinking. Protect the vulnerable by default – device-light alternatives, cautious handling of identity and location, paper or SMS fallbacks when the grid is silent. None of this requires new heroism, only shared discipline and templates that travel from course to course.

For a Ukrainian reader the analogy is unavoidable. Our power grid holds because it is distributed, layered, and repaired faster than it is broken. Our civil defence holds because routines are known and rehearsed. A resilient curriculum must resemble both – distributed across tools, layered across modes, and practised until the pivot is unremarkable. Such a curriculum does more than carry students to exam thresholds. It cultivates judgement, voice, and professional confidence under pressure, which are the communicative assets engineers need to rebuild the country they will inherit.

Future work should tighten causal estimates with better outage telemetry, follow long term retention under intermittent study, and specify ethical guardrails for AI scaffolds in ESP tasks. Yet the central conclusion already stands. Digital resilience is not a toggle to be switched on when sirens sound – it is an engineered property of platforms, pedagogy, and policy, and it keeps English learning alive precisely when everything else is failing.

SUMMARY

This study addresses a clear problem: wartime disruption in Ukraine forces English language instruction for engineering students to operate under power cuts, connectivity loss, displacement, and elevated cognitive stress, so digital resilience becomes a core educational capacity rather than a bonus. We examine how specific platform configurations and teaching routines sustain continuity, equity, and assessment integrity in this context. Using a mixed-methods design,

we link LMS analytics, videoconference metadata, gradebooks, short student and instructor surveys, and reflection notes collected across 2022-2025. We operationalize outcomes through four indices: continuity index, engagement stability, outcome robustness, and equity gap. Quasi-experimental contrasts compare blackout-heavy weeks with more stable weeks, and interrupted time series capture the effect of interventions such as offline-first content bundles, compressed audio with transcripts, and tri-channel mirroring. Redundancy and offline-first design are associated with higher continuity and lower volatility in attendance and submissions, particularly during clustered outage windows. Assessment flexibility that combines versioned tasks, rubric-linked feedback, and brief oral verification preserves integrity without grade inflation and stabilises criterion-level scores. Short, predictable check-ins and rotating micro-orals sustain engagement more effectively than long live lectures under air-raid alerts and curfews. Device-light alternatives, 72-hour submission windows, and cautious data practices narrow equity gaps for phone-reliant, displaced, or sheltering students while respecting safety constraints. We conclude with a practical wartime playbook for technical universities that institutionalises redundancy, offline-first access, assessment flexibility, and privacy-by-design, and we outline a forward research agenda on causal effects under real outage telemetry, long-term retention, and ethical AI scaffolding for ESP tasks.

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Information about the authors:

Nykyporets Svitlana Stepanivna,

Senior English language lecturer,

Vinnitsia National Technical University

95, Khmelnytske shose, Vinnitsia, 21021, Ukraine

Kot Sergii Oleksandrovych,

Candidate of Philological Sciences, Assistant professor,

Vinnitsia National Technical University

95, Khmelnytske shose, Vinnitsia, 21021, Ukraine,

Piddubchak Svitlana Yuriivna,

English language lecturer,

Vinnitsia National Technical University

95, Khmelnytske shose, Vinnitsia, 21021, Ukraine