



Regular Article

Learning formats during armed conflict: a large-scale survey of educational continuity in Ukraine

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HIGHLIGHTS

- The conflict zone strongly predicts the school learning format (Cramér's $V = 0.67$).
- Frontline regions: 93.2% distance learning; rear regions: 62.5% in-person.
- Adjusted relative risk of distance learning is $\sim 4400\times$ higher in frontline vs rear regions.
- Parent-reported technical-support satisfaction varied little across zones.
- Zone-differentiated, crisis-responsive education policies are needed.

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ABSTRACT

This study documents how school learning formats varied across Ukraine's conflict gradient during active war, using a mixed-methods cross-sectional survey with a dominant quantitative strand and a supplementary qualitative strand. Responses from 5224 parents of general secondary students (grades 1–11), collected in October 2024, show that proximity to active combat is strongly associated with the organised use of distance learning rather than the cessation of schooling. In frontline regions 93.2% of families reported distance learning, compared with predominantly in-person instruction in rear regions (62.5%) and mixed formats in near-front regions (70.2%). The association between conflict zone and learning format is very large ($\chi^2(4) = 4741.29$, $p < .001$, Cramér's $V = 0.67$). In a multinomial logistic regression (pseudo- $R^2 = 0.49$) adjusting for settlement type, school type, and ownership, distance learning was about 4400 times more likely, relative to in-person instruction, in frontline than in rear regions (adjusted RRR = 4,446, 95% CI [1,772, 11,152]); descriptively it was roughly 17 times as prevalent. Parent-reported satisfaction with school technical support varied only weakly across zones ($V = 0.07$), a pattern we read cautiously because the online sampling frame under-represents the least-connected families. Open-text responses surfaced crisis-specific priorities: shelter adequacy, connectivity, device access, teacher preparation, and psychological support. Rather than overturning existing crisis-education scholarship, these findings extend it with population-scale evidence and are consistent with the capability approach: families sustained educational capability by shifting modality when in-person instruction became impractical. The results support zone-differentiated, crisis-responsive education policy.

1. Introduction

Armed conflict represents one of the most severe disruptions to educational systems, affecting over 75 million children worldwide (UNICEF, 2025). The invasion of Ukraine in February 2022 precipitated

an unprecedented educational crisis, displacing millions of students and forcing rapid adaptation of learning modalities across the country (Londar & Pietsch, 2023; Semerikov & Mintii, 2026). Understanding how educational systems respond to active conflict conditions provides important insights for educational policy in crisis contexts

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and contributes to the broader literature on educational resilience (Semerikov, Nechypurenko et al., 2026).

This study examines the digital learning environments in Ukrainian secondary schools during active wartime conditions, focusing on how learning formats vary across regions with different levels of conflict exposure. While previous research has documented educational disruption during conflict (Burde et al., 2017), less is known about the specific patterns of adaptation in contexts of protracted, geographically differentiated warfare. Ukraine presents a unique case where active combat occurs in some regions while others maintain relative stability, enabling analysis of educational responses across a conflict gradient (Horna & Pron, 2022; Londer & Pietsch, 2023; Ovcharuk et al., 2023).

1.1. Research context

The Ukrainian educational system serves approximately 4.2 million school-age children across 22,000 general education institutions. Prior to the 2022 invasion, Ukraine had made substantial investments in educational digitalization, including the deployment of learning management systems, electronic journals, and digital content platforms. This pre-existing infrastructure proved critical when schools faced the challenge of maintaining educational continuity under wartime conditions (Shlenova et al., 2024).

The conflict has created three distinct operational contexts for schools. Frontline regions experience active combat, regular air raid alerts, and direct security threats to educational facilities. Near-front regions, while not experiencing ground combat, face missile strikes, infrastructure damage, and population displacement. Rear regions, located in western and central Ukraine, have absorbed internally displaced students while maintaining relatively normal operations, though they are subject to periodic air attacks (Semerikov, Mintii, Bondarenko & Nechypurenko, 2026).

1.2. Significance of the study

This research addresses a gap in the crisis education literature by providing empirical evidence on educational adaptation patterns during active conflict. Previous studies have primarily focused on post-conflict educational reconstruction (Nicolai & Triplehorn, 2003) or refugee education (Betancourt & Khan, 2008), with limited attention to educational continuity within conflict-affected territories. Recent scholarship has extended these frameworks to active conflict settings, documenting psychosocial effects on school participation (Forsberg & Schultz, 2023; Tuntivivat, 2023) and the role of digital infrastructure in sustaining educational access under constant threat (Semenikhina, 2025). Our study makes three contributions.

First, we document at a national scale how learning modality tracks conflict proximity: frontline regions rely far more on distance learning than rear areas do. Education-in-emergencies frameworks emphasize how armed conflict disrupts educational access and infrastructure (Burde et al., 2017; Inter-agency Network for Education in Emergencies, 2024); our data specify how, in a system with pre-existing digital capacity, disruption to *in-person* schooling coincided with the organised continuation of learning at a distance rather than its cessation. We read this through the capability approach (Nussbaum, 2011; Sen, 1999): when in-person instruction becomes impractical under threat, families and schools preserve the capability to keep learning by shifting modality – a response we describe as *conflict-adaptive education*, that is, moving online to keep children learning rather than insisting on classroom teaching.

Second, we provide population-scale quantitative evidence ($N = 5,224$) on the relationship between conflict proximity and learning modality, enabling effect-size estimation beyond the case studies typical of this literature. The very large effect ($V = 0.67$) places conflict zones among the strongest correlates of educational delivery – of a magnitude comparable to the socioeconomic-status differences documented

for academic outcomes in non-crisis settings (Sirin, 2005). This provides a quantitative benchmark for future comparative research.

Third, we analyse parents' open-text accounts of educational quality and improvement needs, adding a bottom-up perspective that complements institutional analyses (Gonzalez-DeHass et al., 2022; Yang et al., 2023). Parent-reported satisfaction with school technical support differed only weakly across zones ($V = 0.07$). We treat this descriptively rather than as evidence against digital-divide theory (van Dijk, 2020): because the online sampling frame under-represents the least-connected families (discussed under Limitations), the measure speaks to reported satisfaction among connected respondents, not to material access across the population.

1.3. Research questions

This study addresses three research questions:

- RQ1: How do learning formats (in-person, distance, mixed) vary across conflict-affected regions in Ukraine?
- RQ2: What factors predict learning format adoption during active conflict?
- RQ3: What themes emerge from parental suggestions for improving digital educational environments during a crisis?

2. Literature review

2.1. Education in emergencies: theoretical foundations

The field of education in emergencies (EiE) has developed substantially since Graça Machel's seminal 1996 report to the United Nations on the impact of armed conflict on children (Machel, 1996). This literature establishes education as both a fundamental human right that must be protected during crises and a practical intervention that provides psychosocial benefits, physical protection, and future economic opportunities for conflict-affected children.

Burde et al. (2017) provide a comprehensive review of theory and research in education in emergencies, identifying four major theoretical perspectives. The human capital perspective emphasizes education's role in post-conflict economic recovery. The human rights framework positions education as a non-derogable right during armed conflict. The psychosocial approach highlights education's protective functions for child development. Finally, the social cohesion perspective examines education's role in peacebuilding and social reconstruction.

Our study draws primarily on the psychosocial and human rights frameworks, examining how educational systems attempt to maintain continuity and normalcy for students during active conflict. The maintenance of regular schooling – where feasible – represents an attempt to preserve developmental normalcy and provide psychological stability during crises (Betancourt & Khan, 2008).

Recent empirical work has continued to build on these foundations. Forsberg and Schultz (2023) demonstrated the effectiveness of combined educational and psychosocial interventions for conflict-affected youth, confirming that school-based continuity supports the protective functions identified in earlier EiE literature. Tuntivivat (2023) documented how armed conflict suppresses school enrolment through both direct security threats and indirect psychological mechanisms, providing quantitative estimates of conflict's impact on educational participation.

2.2. The capability approach and the digital divide

We employ the capability approach (Nussbaum, 2011; Sen, 1999) combined with digital divide theory to examine educational continuity during armed conflict. The capability approach frames education as a fundamental capability that enables individuals to achieve valued functionings – knowledge, skills, economic opportunity, and social participation. During conflict, threats to educational capability arise from both direct security risks and indirect infrastructure disruption. White

and Van der Boor (2021) applied the capability approach specifically to populations forcibly displaced by conflict, demonstrating how conflict-related stressors systematically constrain the capability sets available to displaced individuals and communities – a dynamic directly relevant to the frontline families in our study.

Digital divide theory (van Dijk, 2006, 2020) provides a lens for understanding how technology access shapes educational opportunities. Contemporary conceptualizations distinguish three levels of the digital divide: access (first-level), skills (second-level), and usage outcomes (third-level) (Hargittai, 2002). During conflict, these divides may be exacerbated or mitigated by emergency responses, infrastructure damage, and targeted support programs (Gandolfi et al., 2021; Reynolds et al., 2022).

2.3. Distance learning in crisis contexts

The COVID-19 pandemic catalyzed unprecedented global experimentation with distance and hybrid learning modalities (Bozkurt & Sharma, 2020; Reimers & Reimers, 2022). This experience demonstrated both the potential and limitations of remote instruction, revealing substantial digital divides and raising questions about educational quality in non-traditional formats.

Ukraine's wartime distance learning implementation differs from pandemic-era remote schooling in several important ways. Unlike uniform pandemic lockdowns, conflict-induced distance learning occurs alongside in-person instruction in other regions. This creates comparison conditions and potential migration pressures as families weigh educational modality against safety. Additionally, conflict-related infrastructure damage creates unique challenges for internet connectivity and power supply (Semerikov et al., 2023). Kostikova and Viediarnikova (2023) documented how Ukrainian universities adapted teaching and extracurricular activities to online formats during active conflict, revealing institutional adaptation patterns comparable to those examined here at the school level. Semenikhina (2025) analysed how digital infrastructure vulnerabilities shape flexible learning format choices under conditions of a constant security threat. Elegbede et al. (2026) reviewed technology-mediated educational provision for internally displaced children, identifying transferable lessons about technology's potential to extend educational reach when physical access is disrupted.

Comparable dynamics in other conflict-affected systems help situate the Ukrainian case rather than set it apart. In Sudan, protracted conflict pushed schooling toward distance and non-formal provision, though severe infrastructure damage constrained continuity (Konozy, 2024); schools in Yemen experienced comparable disruption and partial shifts to alternative delivery (International Committee of the Red Cross, 2022). In southern Thailand, armed conflict measurably suppressed school enrolment (Tuntivivat, 2023). Gaza represents the contrasting extreme, where near-total destruction of school infrastructure has largely precluded distance alternatives (Junina, 2026). What distinguishes Ukraine is a pre-war investment in system-level digital capacity that made organised distance provision feasible at scale, even close to the front – a difference that frames the patterns reported below as an extension of, rather than a departure from, this literature.

2.4. Parental perspectives in crisis education

Parents play a central role in educational decision-making during conflict, often determining whether children attend school, participate in distance learning, or discontinue education entirely. Hoover-Dempsey et al. (2005) establish the importance of parental involvement for educational outcomes, while Goodall and Montgomery (2014) emphasize the shift from involvement to engagement as an active partnership.

During crises, parental engagement takes distinctive forms. Parents may assume direct instructional roles in home-based learning, make decisions about family relocation based on educational access, and advocate for school safety improvements. Understanding parental perspectives on crisis education reveals both challenges and potential

solutions that may not be visible from institutional viewpoints (Qualter, 2024; Ribeiro et al., 2021). Lee (2025) demonstrated that online parental communication during crisis conditions is a significant predictor of high school students' intrinsic motivation, highlighting parents' active mediating role in digital learning outcomes.

3. The Ukrainian wartime context

3.1. Timeline of educational disruption

Russia's full-scale invasion of Ukraine began on February 24, 2022, immediately disrupting education for millions of students. The invasion's initial phase saw rapid advances in multiple regions, triggering mass displacement and school closures. By March 2022, the Ministry of Education and Science of Ukraine reported that over 3000 educational institutions had suspended operations, with approximately 1.5 million students displaced internally and 2 million fleeing abroad.

As the conflict stabilized into positional warfare during the summer of 2022, Ukrainian educational authorities developed differentiated policies for different regions. Frontline territories maintained in-person instruction where feasible, arguing that school attendance provided psychological normalcy and that shelters in school buildings offered protection during attacks. Near-front and rear regions implemented varying combinations of distance and mixed learning based on local security assessments and infrastructure capacity.

3.2. Conflict zone classification

For analytical purposes, we classify Ukrainian regions into three conflict zones based on the military situation as of October 2024:

1. *Frontline zone* ($n = 1,658$, 31.7% of sample) comprises the Kharkiv, Donetsk, Zaporizhzhia, Kherson, and Luhansk regions (government-controlled areas). These territories experience active ground combat, regular artillery fire, and direct threats to civilian infrastructure.
2. *Near-front zone* ($n = 1,431$, 27.4% of sample) comprises the Dnipropetrovsk, Mykolaiv, Sumy, Chernihiv, and Odesa regions. These areas experience regular missile and drone attacks targeting infrastructure but not sustained ground combat.
3. *Rear zone* ($n = 2,135$, 40.9% of the sample) comprises the city of Kyiv and the remaining central and western regions – Kyiv, Poltava, Kirovohrad, Zhytomyr, Cherkasy, Vinnytsia, Lviv, Volyn, Rivne, Ternopil, Khmelnytskyi, Ivano-Frankivsk, Zakarpattia, and Chernivtsi oblasts. These territories experience periodic attacks but maintain relatively normal civilian operations.

This zone assignment is the one applied in all analyses below; it follows region-level coding fixed as of October 2024. Two respondents from the Autonomous Republic of Crimea, which is under occupation, are grouped with the rear zone by default and are too few to affect any estimate.

3.3. Study setting: October 2024

Data collection occurred October 7–18, 2024, during a period of intensified missile attacks on Ukrainian infrastructure. The 2024–2025 academic year represents the third full school year under wartime conditions. Schools and families have developed routines for managing air raid alerts, power outages, and periodic displacement. The patterns we observe thus reflect adaptation to a sustained crisis rather than initial emergency response.

4. Methods

4.1. Research design

This study employs a mixed-methods cross-sectional survey design, with a dominant quantitative strand (closed-response items analysed

statistically) and a supplementary qualitative strand (open-text suggestions analysed thematically), to examine patterns of educational delivery across conflict-affected regions of Ukraine. The design enables comparison across the conflict gradient while acknowledging limitations regarding causal inference inherent to observational data.

4.2. Participants and sampling

The sample comprises 5224 parents of general secondary students (grades 1–11), with respondents from every mainland oblast of Ukraine and the city of Kyiv, although coverage is sparse in several central and western oblasts (eight regions contributed fewer than ten responses). Data collection occurred from October 7–18, 2024, through an online survey distributed via teachers' professional networks on Telegram and other messaging platforms. Geographic distribution includes 31.7% from frontline zones ($n = 1,658$), 27.4% from near-front zones ($n = 1,431$), and 40.9% from rear zones ($n = 2,135$). By settlement type, 65.8% of respondents lived in cities ($n = 3,438$) and a further 18.5% in urban-type settlements ($n = 965$) – 84.3% urban overall – with 15.7% in villages ($n = 821$). Parent age distribution shows 35–45 years (60.0%), 27–35 years (22.7%), and over 45 years (17.3%). The sample is 95.8% female. This reflects both the gender composition of parent–school engagement in Ukraine, where mothers typically manage school communication, and the wartime context: under martial law and general mobilisation, men aged 18–60 have been subject to conscription and have been barred from leaving the country since February 2022 (Romanenko, 2022), so mothers predominate among reachable respondents. We treat this as a constraint on generalizability rather than a neutral design feature (see Limitations).

Because the survey was distributed through open Telegram teacher networks, the number of parents who received the invitation is unknown, so a response rate cannot be computed. The convenience sampling approach via professional networks introduces selection bias: parents with stronger school engagement, reliable connectivity, and an enrolled child are structurally over-represented, while families in actively contested areas with limited internet access, displaced families without stable enrolment, and parents with low digital literacy are under-represented or absent by construction. The frame therefore captures connected, enrolled families and cannot speak to children whose schooling has ceased. These limitations are carried through to the interpretation of findings.

4.3. Measures

The primary outcome variable was the learning format, assessed with the item: “How is the educational process currently organised at your school?” Response options included in-person (traditional classroom instruction), distance learning (fully online/remote instruction), and mixed format (combination of in-person and distance learning). The primary predictor was the conflict zone, derived from regional coding into three categories (Frontline, Near-Front, Rear) based on the military situation as of October 2024, following official government designations and independent security assessments.

Control variables included settlement type (village, urban settlement, city), school type (lyceum, gymnasium, general secondary school, general-secondary institution, or educational complex), and school ownership (public or private). A further item measured parent-reported *satisfaction* with school technical support, worded “Are you satisfied with the technical support (help with technical problems) that your educational institution provides for the use of the educational platform?”, with response options ‘Yes’, ‘Partially’, and ‘No, such support is not provided’. The item captures satisfaction with support for platform use as reported by parents; it is not an objective audit of devices, connectivity, or infrastructure. Additionally, parents were invited to provide suggestions for improving the digital educational environment in an open-ended format; responses were given in Ukrainian or Russian and were analyzed thematically.

4.4. Analytical approach

Analysis proceeded in four stages. First, descriptive statistics and cross-tabulations characterized sample composition and outcome distributions. Second, Pearson chi-square tests assessed associations between categorical variables, with effect sizes reported using Cramér's V interpreted following Cohen (1988): $V < 0.10$ negligible, 0.10–0.30 small, 0.30–0.50 medium, > 0.50 large. With $N = 5224$ the design had statistical power exceeding 0.999 to detect even a small association ($w = 0.10$, $df = 4$, $\alpha = .05$), so the effects reported below are not small-sample artefacts. Third, multinomial logistic regression predicted learning format from conflict zone, settlement type, school type, and ownership, reporting relative risk ratios (RRR) with 95% confidence intervals; in-person instruction served as the outcome reference category and the rear zone as the conflict-zone reference. Multicollinearity among predictors was assessed with variance inflation factors (all VIF < 1.6). Fourth, intraclass correlation coefficients (ICCs) assessed regional clustering in outcomes. The open-ended suggestions were analysed following the reflexive thematic-analysis approach of Braun and Clarke (2006): responses were read in full, coded inductively through initial open coding, and the codes were iteratively grouped into higher-order themes, which were then reviewed against the coded extracts, named, and quantified as a share of substantive responses. Coding was carried out by one author; no second coder was involved and no formal inter-rater reliability statistic was computed, a constraint on the qualitative strand that we note in the Limitations.

4.5. Ethical considerations

The survey collected no personal or directly identifying data: no names or e-mail addresses were recorded, and responses were stored and analysed only in aggregate. An introductory note at the start of the online questionnaire identified the research team's institution, explained the purpose of the survey and the intended use of the data, and stated that participation was voluntary and anonymous. Respondents gave consent electronically by proceeding past this note, before reaching any substantive item; any item could be skipped and the questionnaire abandoned at any point without consequence. The questionnaire concerned the organisation of schooling – learning formats, technical support, and suggestions for improvement – and contained no clinical, diagnostic, or otherwise sensitive items, posing no foreseeable risk to participants' emotional or physical wellbeing. Given the wartime context, no data on precise locations or institution names were collected, and regional identifiers were retained only at the oblast level. Under the norms governing educational and pedagogical research in Ukraine, non-interventional, anonymous survey research of this kind does not require separate approval by an institutional ethics committee; such committees are established within medical institutions to review biomedical research. Given the sensitive context of data collection during active conflict, particular care was taken to avoid questions that could compromise participant safety.

5. Results

5.1. Descriptive overview

Table 1 presents the sample distribution across key variables. Learning format shows near-equal distribution across modalities at the national level: 32.7% in-person, 34.4% mixed, and 32.8% distance. This aggregate pattern masks substantial regional variation that constitutes our primary finding.

5.2. Conflict zone and learning format: primary analysis

Our central analysis examines the association between the conflict zone and learning format. Results reveal a very large effect, $\chi^2(4) = 4741.29$, $p < .001$, Cramér's $V = 0.67$, indicating that the conflict zone explains substantial variance in learning modality.

Table 1
Sample characteristics ($N = 5,224$).

Variable	<i>n</i>	%
Conflict zone		
Frontline	1658	31.7
Near-front	1431	27.4
Rear	2135	40.9
Learning format		
In-person	1710	32.7
Mixed format	1798	34.4
Distance learning	1716	32.8
Settlement type		
City	3438	65.8
Urban settlement	965	18.5
Village	821	15.7
Gender		
Female	5006	95.8
Male	218	4.2
Parent age		
27–35 years	1187	22.7
35–45 years	3132	60.0
Over 45 years	905	17.3
School type		
Lyceum	3618	69.3
General school	778	14.9
Gymnasium	526	10.1
General-secondary institution	249	4.8
Educational complex	53	1.0
School ownership		
Public	5204	99.6
Private	20	0.4
Technical support satisfaction		
Yes	3176	60.8
Partially	1527	29.2
No	521	10.0

Table 2
Learning formats by conflict zone.

Conflict zone	Learning format			Total
	In-person	Mixed	Distance	
Frontline	5 (0.3%)	107 (6.5%)	1546 (93.2%)	1658
Near-front	371 (25.9%)	1005 (70.2%)	55 (3.8%)	1431
Rear	1334 (62.5%)	686 (32.1%)	115 (5.4%)	2135
Total	1710 (32.7%)	1798 (34.4%)	1716 (32.8%)	5224

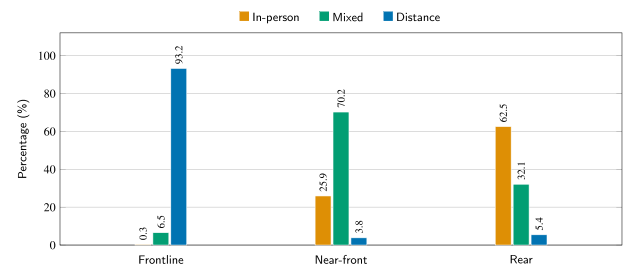
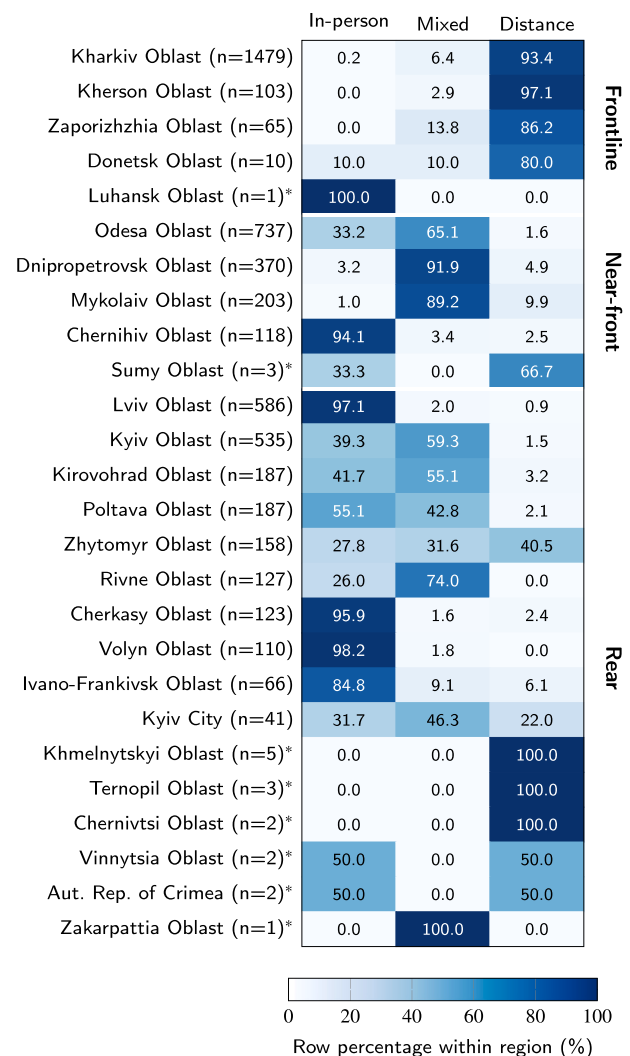
$$\chi^2(4) = 4741.29, p < .001, \text{Cramér's } V = 0.674.$$

As Table 2 shows, the pattern is a steep modality gradient: frontline regions are predominantly distance learning (93.2%), near-front regions rely mainly on mixed formats (70.2%), and rear regions favour in-person instruction (62.5%). Fig. 1 visualizes these differences across conflict zones, while Fig. 2 provides regional detail. The zone aggregates conceal within-zone heterogeneity that the regional breakdown makes visible: within the near-front zone, Chernihiv oblast is 94.1% in-person, whereas Odesa, Dnipropetrovsk, and Mykolaiv are 65–92% mixed; and in the rear zone Zhytomyr oblast reports 40.5% distance learning against a zone norm below 6%. Estimates for the eight sparsely sampled regions ($n < 10$) are unstable and are not interpreted.

5.3. Multinomial logistic regression

Multinomial logistic regression examined predictors of learning format, using in-person instruction as the reference category. Conflict zone remained the strongest predictor after controlling for settlement type.

As Table 3 reports, net of settlement type, school type, and ownership, schools in frontline regions were about 4400 times more likely to operate in distance mode than in person, relative to rear-region schools

**Fig. 1.** Learning format distribution by conflict zone (row percentages within zones; $N = 5,224$). Frontline regions are predominantly distance learning (93.2%); rear regions favour in-person instruction (62.5%); near-front regions are mostly mixed format (70.2%).**Fig. 2.** Learning-format distribution by region (row percentages within region; conflict-zone blocks per the study's classification). Regions with $n < 10$ (marked *) have unstable percentages and should be read with caution.

(adjusted RRR = 4,446, 95% CI [1,772, 11,152]). School type was also associated with modality: general schools and general-secondary institutions were markedly less likely than lyceums to use distance or mixed formats. School ownership was not associated with modality – the private-school estimates were non-significant with wide confidence intervals, reflecting only 20 private-school cases. Descriptively, distance

Table 3
Multinomial logistic regression predicting learning format.

Predictor	Mixed vs In-person		Distance vs In-person	
	RRR	95% CI	RRR	95% CI
Intercept	1.07	[0.95, 1.20]	0.14	[0.11, 0.18]
Frontline (vs Rear)	60.9	[24.2, 153]	4446	[1772, 11,152]
Near-front (vs Rear)	5.02	[4.18, 6.03]	1.41	[0.97, 2.05]
Urban settlement (vs City)	0.15	[0.11, 0.20]	0.42	[0.28, 0.63]
Village (vs City)	0.69	[0.55, 0.87]	0.89	[0.60, 1.33]
General school (vs Lyceum)	0.13	[0.10, 0.17]	0.24	[0.15, 0.37]
Gymnasium (vs Lyceum)	0.76	[0.60, 0.97]	1.29	[0.83, 2.00]
General-secondary (vs Lyceum)	0.08	[0.05, 0.13]	0.35	[0.18, 0.69]
Educational complex (vs Lyceum)	1.85	[0.76, 4.53]	1.07	[0.31, 3.73]
Private (vs Public)	0.71	[0.21, 2.41]	1.55	[0.23, 10.5]

Note. RRR = relative risk ratio; CI = confidence interval. $N = 5224$. Pseudo- $R^2 = 0.49$; AIC = 5858. Outcome reference: in-person; conflict-zone reference: rear; settlement reference: city; school-type reference: lyceum; ownership reference: public. Bold indicates $p < .05$. The intercept is the modality odds for the reference cell, not a between-zone ratio. The frontline in-person cell contains only 5 observations, so the frontline distance-learning estimate has a correspondingly wide confidence interval.

learning was about 17 times as prevalent in frontline regions as in rear regions (93.2% vs 5.4%).

5.4. Regional patterns and settlement effects

Intraclass correlation analysis confirms substantial regional clustering in the learning format: ICC = 0.68 across the 26 regions, indicating that roughly two-thirds of the variance in learning format lies between regions rather than within them.

Adjusted standardized residuals identify which specific cells drive the significant chi-square association. Frontline regions show extreme positive residuals for distance learning (+63.38) and negative residuals for in-person instruction (−34.06), indicating far more distance learning than expected under independence. Rear regions show the opposite pattern: positive residuals for in-person instruction (+38.09) and negative residuals for distance learning (−35.13). Near-front regions deviate most strongly toward the mixed format (+33.46). All residuals substantially exceed the critical value of |1.96|, indicating statistically significant deviations throughout.

Settlement type demonstrates a smaller but significant association with learning format, $\chi^2(4) = 577.94$, $p < .001$, $V = 0.24$. Urban settlements report higher rates of distance learning (62.7%) compared to cities (26.1%) and villages (26.2%), while cities favour in-person instruction (36.4%). Villages show the highest mixed format adoption (49.0%), potentially reflecting infrastructure challenges in urban settlements and community cohesion in villages. In the multinomial model, however, these settlement associations change once conflict zone is included: urban-type settlements are then *less* likely than cities to use distance or mixed formats (Table 3). This sign reversal indicates that the bivariate settlement pattern largely reflects where such settlements sit on the conflict gradient; conflict zone is the more fundamental predictor.

5.5. Technical support across conflict zones

Parent-reported satisfaction with technical support shows only a weak association with conflict zone, $\chi^2(4) = 50.66$, $p < .001$, $V = 0.07$ (Table 4). Frontline parents report slightly higher full satisfaction (66.9%) than near-front (60.7%) and rear (56.2%) parents. We interpret this near-uniformity cautiously. Because the online frame under-represents families with the weakest connectivity – who are also the most likely to report inadequate support – the small effect probably overstates how evenly support is distributed, and reflects satisfaction among connected respondents rather than material infrastructure across the whole population. Fig. 3 illustrates these patterns,

Table 4
Technical support by conflict zone.

Conflict zone	Technical support			Total
	No	Partially	Yes	
Frontline	137 (8.3%)	412 (24.8%)	1109 (66.9%)	1658
Near-front	163 (11.4%)	400 (28.0%)	868 (60.7%)	1431
Rear	221 (10.4%)	715 (33.5%)	1199 (56.2%)	2135
Total	521 (10.0%)	1527 (29.2%)	3176 (60.8%)	5224

$\chi^2(4) = 50.66$, $p < .001$, Cramér's $V = 0.07$.

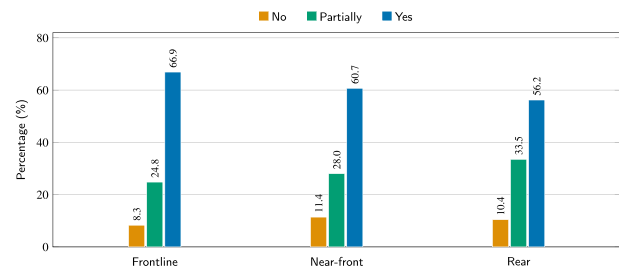


Fig. 3. Parent-reported satisfaction with school technical support for platform use, by conflict zone (row percentages within each zone). Full satisfaction ('Yes') is highest in frontline regions (66.9%).

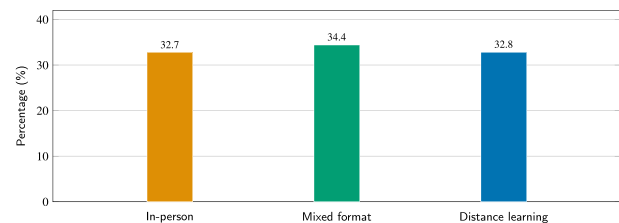


Fig. 4. Distribution of learning formats across the sample ($N = 5,224$).

Table 5
Summary of chi-square tests.

Comparison	<i>df</i>	χ^2	<i>p</i>	<i>V</i>	<i>N</i>
Conflict zone × Learning format	4	4741.29	< .001	0.67	5224
Conflict zone × Technical support	4	50.66	< .001	0.07	5224
Settlement × Learning format	4	577.94	< .001	0.24	5224

and Fig. 4 presents the overall sample distribution of learning formats. Table 5 consolidates the three chi-square tests reported across this section.

5.6. Thematic analysis of parental suggestions

Of 5224 respondents, 1847 (35.4%) provided substantive suggestions for improving digital educational environments. Thematic analysis revealed five interconnected themes reflecting crisis-specific concerns. Table 6 presents each theme with its frequency and a representative, anonymized parent quote.

Shelter and safety infrastructure emerged as the most frequent theme (23.2%), with parents emphasizing the need for modernized facilities with proper ventilation, capacity for extended stays during alerts, and shelter-based instruction capabilities. As one parent noted: “We need proper shelters where children can continue learning during air raids, not just corridors where they sit for hours”. Internet connectivity concerns (21.7%) varied by zone: frontline parents emphasized satellite internet for power outages, near-front parents reported bandwidth

Table 6
Themes in parental suggestions ($n = 1,847$ substantive responses), with a representative quote.

Theme	%	Representative parent suggestion (translated)
Shelter and safety infrastructure	23.2	"We need proper shelters where children can continue learning during air raids, not just corridors where they sit for hours."
Internet connectivity	21.7	"Uninterrupted internet, even during power outages and while in shelters."
Device access	18.4	"Provision of modern computers, tablets, and other devices for students."
Teacher training	17.8	"More training aimed at raising the level of digital competencies."
Psychological support	11.3	"Add free psychological support."

Quotes are verbatim, anonymized responses translated from Ukrainian; no school, settlement, or personal names appear. Percentages are of the 1847 substantive responses.

limitations, and rear parents highlighted equity concerns for families with limited access.

Device access (18.4%) represented the third most frequent theme, with parents requesting school-provided devices for families without computers, tablet programs for younger students, and technical support for troubleshooting device issues. Teacher training (17.8%) focused on professional development for online instruction, platform-specific skills, and interactive teaching methods for digital formats. Psychological support (11.3%) emerged as the final theme, encompassing school-based psychologists for trauma support, parent guidance on supporting children’s learning during crises, and stress management strategies for students in distance formats.

6. Discussion

Before interpreting the findings we note the study’s principal strengths. It documents learning-format provision for 5224 families across the Ukrainian conflict gradient during active war – a scale and setting rarely available in crisis-education research – with consistent effect-size reporting, oblast-level regional detail, and an analysis of regional clustering. Its distinctive contribution is not a surprising direction of effect but the precision and scale with which a system-level distance-education response is documented, alongside a qualitative strand that surfaces the needs families themselves prioritize. This combination is what distinguishes the Ukrainian case from settings such as Sudan, Yemen, and Gaza, where infrastructure damage foreclosed comparable continuity.

6.1. The frontline distance-learning pattern

The most consequential finding is that frontline regions rely overwhelmingly on distance learning (93.2%), while regions further from active combat use more in-person and mixed formats. This gradient is consistent with safety logic, with Ukraine’s differentiated regional closure policy, and with the comparative evidence reviewed earlier; the contribution here is to document it at population scale and to quantify its magnitude with precision, not to report a surprise.

We propose four complementary supply-side explanations for this pattern. The infrastructure damage hypothesis suggests that frontline regions experience severe infrastructure damage – power outages, internet disruptions, school building destruction – making distance learning more resilient when physical infrastructure is compromised. The evacuation hypothesis posits that families remaining in frontline areas constitute a selected population with strong place attachments or limited mobility options, who may have already established distance learning arrangements during earlier evacuation periods. The shelter constraint hypothesis notes that while schools in frontline areas have shelters, capacity constraints and safety protocols may make in-person attendance

impractical when air raid alerts occur multiple times daily. Finally, the temporal pattern hypothesis recognizes that the 2024–2025 academic year represents the third year of conflict, and frontline schools that initially maintained in-person instruction may have transitioned to distance learning as infrastructure degraded and populations shifted. These are hypotheses that our cross-sectional data cannot adjudicate, and none of the underlying mechanisms was measured directly. Demand-side processes may also contribute: parents in frontline areas may keep children at home to avoid the daily exposure of the school commute, and because school buildings are themselves targets, avoiding in-person congregation can be protective (Global Coalition to Protect Education from Attack, 2024). Distinguishing these mechanisms would require longitudinal and administrative data.

6.2. The theoretical contributions

Our findings contribute to crisis education theory in several ways. First, we demonstrate that conflict-education relationships are non-linear and context-dependent, challenging linear models of conflict impact. Simple models predicting that conflict proximity uniformly disrupts education fail to capture the complex adaptations schools and families make under varying security conditions. The capability approach (Nussbaum, 2011; Sen, 1999) proves useful here: frontline families prioritize the capability to continue education through distance modalities when in-person instruction becomes impractical, rather than abandoning education entirely.

Second, we provide evidence for education’s protective function during conflict, though in unexpected ways. The strong preference for distance learning in frontline areas suggests that educational continuity – even in virtual form – is prioritized when physical attendance becomes impractical. This extends the psychosocial framework in the education in emergencies literature (Burde et al., 2017): distance learning provides not just educational continuity but also psychological stability through routine maintenance when other forms of normalcy are impossible.

Third, our effect size estimates enable a more precise understanding of conflict impacts. The very large association between conflict zone and learning format ($V = 0.67$) indicates that the conflict context is among the strongest determinants of educational delivery, of a magnitude comparable to the socioeconomic-status differences documented for academic outcomes in non-crisis settings (Sirin, 2005). This finding has implications for how we conceptualize the relationship between conflict intensity and educational adaptation: proximity to active combat does not simply reduce educational opportunity but fundamentally transforms its modality.

6.3. A theory of conflict-adaptive education

The pattern documented here – frontline regions relying more heavily on distance learning than rear areas – invites theoretical explanation. We propose *conflict-adaptive education* as a framework for understanding how educational systems respond to sustained threat. Under this framework, schools and families make modality choices based on a calculus that weighs educational capability against safety constraints. When in-person instruction becomes impractical due to security threats, infrastructure damage, or shelter limitations, educational systems adapt by shifting to distance modalities rather than ceasing operations entirely.

Crisis education literature (Burde et al., 2017; Nicolai & Triplehorn, 2003) frames conflict as disrupting educational access; our findings specify one form this takes in a system with digital capacity. Among families whose children remained enrolled in functioning schools, conflict transformed the *modality* of provision rather than ending it. The scope condition matters: because the sample cannot observe children whose schooling ceased, this is a statement about modality within the enrolled, connected population, not a claim that conflict does not eliminate educational opportunity. Nor do we read the weak zone gradient in technical-support satisfaction ($V = 0.07$)

as overturning digital-divide theory (van Dijk, 2020): the measure is filtered through the same connectivity-based selection, and while Ukraine's pre-war digital investment plausibly supported distance provision, we cannot attribute the observed uniformity to any specific programme.

The conflict-adaptive education framework suggests that educational resilience during conflict depends on three preconditions: (1) pre-existing digital infrastructure, (2) sustained support for connectivity and devices, and (3) policy frameworks allowing local adaptation to security conditions. These preconditions help explain why the pattern documented here differs from other conflict contexts where educational disruption has been more severe (Konozy, 2024).

6.4. Comparison with literature

Our findings extend previous research on Ukrainian education during wartime (Londar & Pietsch, 2023; Ovcharuk et al., 2023; Semerikov et al., 2023) by providing quantitative effect-size estimates and multinomial regression analysis. Londar and Pietsch (2023) documented qualitative patterns of distance education adaptation in frontline regions; our findings quantify these patterns, with frontline schools about 4400 times as likely as rear-region schools to operate in distance rather than in-person mode after adjustment (Table 3). Lorincz et al. (2025) corroborate these patterns, reporting that secondary school students and teachers in Ukraine consistently identify connectivity instability and uneven pedagogical quality as barriers to effective online learning. The early cross-regional analysis by Horna and Pron (2022), conducted in the initial months of the full-scale invasion, identified the same heterogeneity in learning format adoption that our data now quantify at a national scale. The ICC of 0.68 confirms substantial regional clustering, supporting the view that local context strongly shapes educational adaptation.

The weak zone gradient in technical-support satisfaction ($V = 0.07$) sits uneasily against the literature documenting widened digital divides during emergency remote teaching (Gandolfi et al., 2021; Reynolds et al., 2022), but the comparison is not like-for-like. Pandemic studies such as Gandolfi et al. (2021) retained offline-disadvantaged students within their sampling frames, whereas our online recruitment excludes the least-connected families at the point of entry, so an apparent absence of a divide may partly be an artefact of who could respond. We therefore offer, rather than assert, three explanations for the slightly higher frontline satisfaction: (i) concentrated governmental and international provision of devices and connectivity in frontline hotspots (UNICEF Ukraine, 2023); (ii) reference-frame effects, whereby frontline parents may judge support against harsher baselines; and (iii) the selection filter itself, since the frontline families least well served are the least likely to appear in an online survey. Our data cannot distinguish among these, and none of the underlying programmes or mechanisms was measured directly. However, parental suggestions indicate unmet needs in shelter quality, connectivity stability, and device access that the closed-ended measures understate. This discrepancy between survey measures and open-ended responses highlights the value of the mixed-methods design: closed-ended questions may miss context-specific challenges that emerge organically in open responses.

6.5. Comparison with other conflict contexts

As the comparison with Sudan, Yemen, Thailand, and Gaza set out in the literature review makes clear, the direction of Ukraine's shift toward distance provision is not unusual among conflict-affected systems; what is distinctive is that relatively intact, pre-war digital infrastructure has allowed that shift to be organised at a national scale rather than leaving a vacuum. School-based continuity of this kind is associated with measurable developmental benefits for conflict-affected children (Forsberg & Schultz, 2023).

A key difference from the post-conflict education literature is our focus on active conflict rather than reconstruction. Studies of post-conflict education in Nepal (Pherali & Garratt, 2014), Sierra Leone, and Liberia examine educational recovery after violence ends. Our contribution documents educational adaptation during ongoing violence, when infrastructure continues to be damaged and populations continue to be displaced. This distinction matters: policies for education during active conflict must prioritize resilience and rapid adaptation, while post-conflict education emphasizes reconstruction and reintegration.

6.6. Implications for sustainable development goal 4

Our findings bear directly on Sustainable Development Goal 4 (Quality Education) and its commitment to inclusive, equitable, quality education for all. The very large effect of conflict zone on learning format ($V = 0.67$) indicates that SDG 4 progress is fundamentally shaped by conflict exposure. Rose and Sayed (2024), reviewing global SDG 4 progress, note that monitoring frameworks remain inadequate for capturing within-country regional variation of the kind that our conflict-gradient design documents. Ukraine's achievement of SDG 4 targets prior to 2022 was substantial – near-universal primary and secondary enrolment, high digital literacy, extensive educational technology adoption. Our findings demonstrate how conflict reverses these gains asymmetrically: frontline regions show near-complete transition to distance learning, with implications for educational quality and equity.

The capability approach (Nussbaum, 2011; Sen, 1999) provides a useful framework for understanding these dynamics. Conflict does not merely reduce educational access but transforms the capabilities that families can exercise in pursuing education. Frontline families maintain educational capability through distance modalities, but this comes at a cost: reduced peer interaction, limited teacher support, and psychological strain from learning while under threat. Development policy must therefore address not just educational access but also the quality of educational capabilities under conflict conditions.

6.7. Policy implications

We separate recommendations that follow directly from our findings from broader suggestions that rest on external evidence.

Grounded in the findings. First, the steep modality gradient – and the near-front zone's reliance on mixed formats (70.2%) – argue for zone-differentiated rather than uniform policy, and specifically for standard procedures governing rapid transitions between in-person, mixed, and distance formats as local security conditions change. Second, the dominant parental theme, shelter and safety infrastructure (23.2%), voiced directly in requests for spaces where learning can continue during alerts, supports minimum standards for safe learning spaces and school shelters (Abusamra et al., 2023; Inter-agency Network for Education in Emergencies, 2024). Third, the connectivity (21.7%), device-access (18.4%), teacher-training (17.8%), and psychological-support (11.3%) themes each identify a concrete provision gap: resilient connectivity and devices for distance and mixed settings, professional development for online and hybrid teaching, and school-based psychological support for students learning under threat.

Broader suggestions. Beyond what our data can adjudicate, the frontline reliance on distance learning points to the value of connectivity that is resilient to power and infrastructure disruptions, and the presence of displaced students in rear regions points to integration and catch-up needs; we flag these as directions supported by the wider crisis-education literature (Elegbede et al., 2026; Inter-agency Network for Education in Emergencies, 2024) rather than as findings of this study. Because we did not analyse outcomes by student grade, trauma exposure, or displacement status, we refrain from device-by-age, trauma-pedagogy, or displacement-specific prescriptions.

6.8. Limitations

Six limitations affect interpretation of these findings:

1. *Sampling bias*: The convenience sampling approach via Telegram teacher networks introduces substantial selection bias. Parents reached through teacher networks likely represent more engaged, educationally invested families. Marginalized populations – including displaced families without stable school enrolment, families in remote rural areas with limited internet access, and parents with low digital literacy – are underrepresented. This bias likely overestimates technical support access and underestimates infrastructure challenges faced by the most vulnerable populations. Most consequentially, children whose schooling has ceased entirely – through displacement, non-re-enrolment, or residence in occupied territory – cannot enter an online survey of enrolled families at all. Our claims about learning modality therefore hold within the enrolled, connected population and must not be read as evidence that conflict does not eliminate educational opportunity.
2. *Gender distribution*: The sample is 95.8% female. This reflects gender patterns in school engagement in Ukraine, where mothers typically manage educational communication with schools, but it limits generalizability to fathers' perspectives. The predominance of women is also shaped by general mobilisation, which since 2022 has removed many men aged 18–60 from the civilian population (Romanenko, 2022); the sample thus mirrors a wartime demographic reality, and generalisation to two-parent educational decision-making should be cautious. Fathers' views on learning format preferences, technical support needs, and suggestions for improvement may differ systematically.
3. *Cross-sectional design*: The single time-point design prevents causal inference about the effects of conflict on learning format. We cannot determine whether frontline regions adopted distance learning because of conflict, or whether pre-existing distance learning infrastructure influenced resilience. Longitudinal data tracking changes over time would enable stronger causal claims.
4. *Temporal specificity*: Data collection occurred during October 7–18, 2024, capturing a specific moment in an evolving conflict. Military conditions, infrastructure damage, and displacement patterns change continuously; findings may not generalize to other time periods. Regional classifications (frontline, near-front, rear) reflect October 2024 conditions and may shift with changing conflict dynamics.
5. *Self-report limitations*: Parents reported the learning format based on their understanding, which may not precisely reflect school designations. Mixed format, in particular, may encompass various hybrid arrangements that parents interpret differently.
6. *Single-coder qualitative analysis*: The thematic coding reported above was performed by one author, without double-coding or a formal reliability check. The theme boundaries and the shares given in Table 6 therefore reflect a single analytic reading, and the qualitative strand should be read as illustrative of the quantitative pattern rather than as an independently validated typology.

6.9. Future research

Longitudinal tracking of learning format changes would enable analysis of how schools adapt to evolving conflict conditions. Multilevel modeling incorporating school-level factors would help decompose regional clustering. Outcome studies linking learning format to educational achievement would address whether format differences translate to learning differences. Qualitative research with school administrators would provide institutional perspectives complementing parent-focused data.

6.10. Educational sustainability during protracted conflict

The patterns documented here raise questions about educational sustainability during protracted conflict. Ukraine's educational system has maintained operation for three academic years under wartime

conditions, demonstrating remarkable institutional resilience. However, sustainability requires addressing several challenges identified in our findings.

Infrastructure sustainability demands investment in resilient connectivity – satellite internet, backup power systems, redundant communication channels – that can function despite infrastructure attacks. Semenikhina (2025) identifies flexible format design principles for conditions of variable infrastructure threats, while Elegbede et al. (2026) demonstrates that targeted technology provision can extend educational reach to displaced populations even when physical school access is disrupted. The high reliance on distance learning in frontline areas (93.2%) makes educational continuity dependent on digital infrastructure that remains vulnerable to disruption. Teacher sustainability requires professional development programs that build capacity for crisis-responsive pedagogy, including trauma-informed instruction, format flexibility, and technology integration. The parental suggestions emphasizing teacher training (17.8%) indicate unmet professional development needs. Student sustainability involves not just access to learning materials but psychological support for learning under threat. The psychological support theme (11.3%) in parental suggestions reflects concern for student well-being alongside educational outcomes.

For other conflict-affected contexts, Ukraine's experience suggests that educational sustainability during protracted conflict requires pre-existing digital infrastructure, sustained international support for connectivity and devices, teacher training investment before crisis onset, and flexible policy frameworks that allow local adaptation to security conditions.

7. Conclusion

This study examines educational continuity during armed conflict in Ukraine, analyzing how learning formats vary across regions with different levels of conflict exposure. Using survey data collected in October 2024 from 5224 parents, we find that conflict zone status has a very large effect on educational delivery ($V = 0.67$), documented here at a population scale.

This research makes three contributions to understanding education in conflict contexts. First, we document at a national scale that frontline regions maintain predominantly distance learning (93.2%) despite proximity to active combat, while rear regions favour in-person instruction (62.5%) – a modality gradient we describe as *conflict-adaptive education*, in which schooling shifts format to preserve educational capability rather than ceasing. Second, multinomial regression confirms the conflict zone as the strongest predictor of learning format (pseudo- $R^2 = 0.49$; adjusted frontline-versus-rear distance-learning RRR = 4.446), with effect sizes that enable more precise understanding of conflict impacts. Third, parent-reported technical-support satisfaction varied only weakly across zones ($V = 0.07$); we read this cautiously, given that the online frame under-represents the least-connected families, rather than as evidence against digital-divide theory.

For educational practitioners and policymakers, our findings suggest that crisis education policies should be differentiated by conflict intensity rather than applied uniformly. The strong reliance on distance learning in frontline areas indicates the need for resilient digital infrastructure and teacher training for online instruction. The weak zone gradient in reported technical-support satisfaction should be read with caution given the sampling frame, and does not by itself establish equitable provision.

CRedit authorship contribution statement

Iryna V. Ivaniuk: Writing – review & editing, Validation, Supervision, Resources, Methodology, Investigation, Conceptualization. **Olha P. Pinchuk**: Writing – review & editing, Project administration, Investigation, Formal analysis, Data curation. **Serhiy O. Semerikov**: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Investigation.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the authors used Claude (Anthropic) for language editing and clarity improvements. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

The dataset analysed in this study is openly available via Zenodo at <https://doi.org/10.5281/zenodo.15231534> under a Creative Commons Attribution-No Derivatives 4.0 International licence.

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