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# Networked resilience at a distance: how the scientific diaspora sustains Ukrainian higher education in wartime — and why military education remains disconnected

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# Networked resilience at a distance: how the scientific diaspora sustains Ukrainian higher education in wartime — and why military education remains disconnected


## Abstract

In the first year of the full-scale invasion, Ukrainian science lost more than a third of its funding and thousands of researchers — yet the share of internationally co-authored university publications rose to nearly a third of total output. This article explains the paradox through the quiet infrastructure of personal networks built by displaced scholars, and asks why one segment of the system — military education — remains outside it. The study combines bibliometric mapping of a 12,101-record Scopus corpus (2012–2026), network analysis of the field's term structure, secondary analysis of the Ukrainian Science Diaspora initiative's published materials — a public registry of 447 scholars and 18 organisations, surveys of 300 diaspora members and 30 university representatives, a corpus of 34 published in-depth interviews, and mentoring programme statistics — and the general sections of an expert survey in military education (n = 12). The network proves feminised, young in emigration terms and massively dual-present: a third of participants work for Ukrainian institutions remotely; every second mentoring pair converts into a measurable outcome; and the barriers named by the diaspora and by universities mirror each other — both sides see missing connective tissue rather than each other. The military gap is constitutive in nature: secrecy regimes preclude open networks for the classified core. Yet the non-classified band along that boundary remains almost empty despite the absence of security obstacles. The article proposes networked internationalisation under wartime immobility as an extension of internationalisation at a distance, and outlines a design for populating the open band.



*Keywords: scientific diaspora; networked resilience; internationalisation at a distance; military education; wartime immobility; social network analysis; displaced scholars; Ukraine*

# 1. Introduction

Ukrainian science should no longer exist — at least if one believes its balance sheet. In the first year of the full-scale invasion, gross expenditure on research and development fell by more than a third (UNESCO 2024). Over one thousand four hundred scholars exchanged a Ukrainian affiliation for a foreign one within the first eighteen months of the war alone (Ganguli and Waldinger 2024; CWTS 2026); millions of Ukrainians found themselves abroad, among them a disproportionate share of highly educated women, since men aged 18–60 are barred from leaving. Shelled campuses, relocated universities, teaching from bomb shelters (Ministry of Education and Science of Ukraine 2024; Zayachuk 2024; for a review of displacement and higher education see Denisova-Schmidt and Marmilova 2026) — all of this should have added up to a story of collapse. Instead, the share of internationally co-authored publications by Ukrainian universities did not fall during the war years but rose — to nearly a third of total research output (Hladchenko 2026). A system that lost money and people gained connections.

This paradox is the article's point of departure. We argue that its explanation lies not in the heroism of individual institutions, though there is no shortage of that, but in the quiet infrastructure of personal networks: displaced scholars did not vanish from Ukrainian science — they changed their mode of presence in it. Dual affiliations, remote teaching, joint applications, mentoring of junior colleagues from abroad: these are the channels through which competence, reputation and access return home without the people returning. Ukrainian scholarly diaspora has a long tradition of self-organisation — from the Shevchenko Scientific Society, founded in 1873, to the academic structures of the post-war emigration — but for the first time this self-organisation is unfolding in a digital environment, in real time, and during the active phase of a war.

The empirical field of the study is the largest of the new structures — the Ukrainian Science Diaspora initiative: a map uniting some four hundred and fifty scholars across eighteen national chapters, with a mentoring programme and partnerships ranging from MIT to line ministries (Polishchuk et al. 2023). Alongside it operate networks of a different nature: the volunteer platform #ScienceForUkraine with thousands of support offers (Rose et al. 2026), fellowship schemes such as MSCA4Ukraine, and institutional twinning between British and Ukrainian universities. Together they form a natural experiment: four different network responses to the same shock.

One part of the higher education system, however, stays outside this experiment. Military education — twelve higher military educational institutions that the war has loaded as never before — internationalises almost exclusively through institutional channels: NATO programmes, bilateral agreements, the joint JATEC training centre. The personal, network dimension — the very one that pulled the civilian segment through — is nearly absent here. Our bibliometric analysis of a corpus of twelve thousand publications shows that the intersection of the literatures on military education and on diaspora or scholarly networks is empty: not a single publication in twelve years, and on the map of the field military-education vocabulary forms no visible cluster. The asymmetry has a gendered face as well: the wartime scientific diaspora is predominantly female, while military education is predominantly male and non-mobile — mobility is blocked in mirror image (Jaroszewicz et al. 2025).

The study answers three questions. First: what network structures has the Ukrainian scientific diaspora formed since 2022 — where are its clusters, who are its brokers, how far is it oriented towards Ukraine rather than closed in on itself. Second: through which mechanisms do these networks actually sustain educational and research continuity — from mentoring pairs to transfers of access and data. Third: why does the military segment remain disconnected, and which configurations could bridge the divide. The answers follow a mixed-methods social network analysis design: the quantitative core maps the structures visible in the initiative's public materials and the field's term network; the qualitative layer draws on published interviews with network participants and expert evidence from military education.

The article's contribution is threefold. Theoretically, we extend the category of internationalisation at a distance (Mittelmeier et al. 2020) into the concept of networked internationalisation under wartime immobility — a regime in which personal networks become the only channel of the international dimension for segments locked in place by war. Empirically, we present the first network portrait of a warring country's scientific diaspora assembled during the war rather than in retrospect. Practically, we propose an evidence-based typology of network interventions for the most closed segment of education, grounded in what is known about which nodes and ties in such networks do the work. The article proceeds as follows: section 2 builds the conceptual framework and quantifies the gap; section 3 describes the context and data; section 4 the methods; section 5 presents the results across the three questions; section 6 discusses implications for theory, policy and post-war recovery.

## 2. Conceptual framework

### *2.1. From loss to network: how the understanding of scholarly emigration changed*

For decades, research on scientific migration rested on the drainage metaphor: the country a scholar leaves loses their productivity irrevocably, and the destination country gains it. In the late 1990s this optic began to shift. Meyer (2001) set a 'network approach' against the brain-drain logic: a diaspora is not a lost resource but a distributed one, and the question is not how to bring people back but how to connect their competences to the country of origin. Saxenian (2005, 2006) showed, on the cases of Taiwan, Israel and India, that transnational technical communities can carry knowledge, standards and capital home without their carriers physically returning — brain circulation instead of brain drain. Within a few years the empirical base of this view looked convincing: the review by Meyer and Wattiaux (2006) recorded 'vanishing doubts' about diaspora knowledge networks.

The economics of science added the causal weight this early literature lacked. Using the expulsion of scholars from Nazi Germany, Becker, Lindenthal, Mukand and Waldinger (2024) showed that professional networks determined who managed to emigrate and where: ties saved careers in the literal sense, and the surviving émigrés visibly fed science and invention in the receiving countries (Moser et al. 2014). Iaria, Schwarz and Waldinger (2018) measured the reverse side: the collapse of international science during the First World War slowed precisely the frontier research most dependent on foreign knowledge. The Ukrainian case already has quasi-experimental estimates of its own: comparing occupied and government-controlled communities after 2014, Guariglia, Nikolsko-Rzhevskyy, Talavera and Zadorozhna (2025) record a productivity drop of over twenty per cent, with the weakening of international research ties among the mechanisms of the blow; difference-in-differences estimates of the full-scale war's impact on universities paint a similar picture (Brintseva 2026). The current literature on academics in exile (Axyonova et al. 2022) and on practices of engaging scientific diasporas (Bonilla et al. 2023) confirms the same point: networks are the main resource that displacement does not destroy. Together these results ground the article's point of departure: networks are not an accompanying circumstance of scientific life but its load-bearing infrastructure — which is why a wartime shock to science is, first of all, a network shock.

### *2.2. Networked resilience: what holds a system when institutions are overloaded*

If networks are infrastructure, a system's resilience in crisis depends on their architecture. Norris, Stevens, Pfefferbaum, Wyche and Pfefferbaum (2008) described community resilience through networked adaptive capacities — an optic already applied to Ukrainian university communities (Błaszczyk et al. 2025): not a reserve of strength, but a network's ability to redirect resources, information and support quickly to where the blow lands. Which ties do this work is a classical question. Granovetter (1973) showed that new information travels along weak ties connecting distant parts of the social structure; Burt (2004) — that ideas and brokerage rents are born on structural holes, where a person sits at the intersection of groups that otherwise do not talk. For a geographically dispersed diaspora, these mechanisms run into the problem of trust without shared space. Jarvenpaa and Leidner (1999) found that trust in virtual teams is possible but 'swift' and brittle: it rests on the rhythm of communication and rapid demonstrations of reliability rather than on shared history. The organisational answer to this brittleness is communities of practice (Wenger

1998) — durable circles of mutual learning around a common cause: this is exactly how the national chapters of diaspora initiatives work. Finally, Diminescu (2008) captured the change in the very figure of the migrant: the contemporary migrant is not cut off from home but permanently connected, and displacement no longer means disconnection.

### *2.3. Internationalisation at a distance and its military boundary*

Research on the internationalisation of higher education offers its own language for situations where knowledge crosses a border without the person. Mittelmeier, Rienties, Gunter and Raghuram (2020) distinguished internationalisation at a distance as a third category alongside internationalisation at home and abroad: a student or lecturer interacts with a foreign institution while physically remaining in their own country. Bruhn-Zass (2021) developed the adjacent notion of virtual internationalisation as a cross-cutting dimension of institutional strategy. This literature, born of digitalisation and the pandemic, described distance as a constraint education had learned to work around. Wartime Ukraine turns distance into a constitutive condition: men aged 18–60 cannot leave, a large share of female scholars are displaced abroad, and the 'at a distance' channel becomes not one option among several but the only available mode of internationalisation for entire segments of the system. The asymmetry of this immobility — women can leave but lose institutional anchoring; men keep institutions but lose mobility (on wartime immobility as a phenomenon in its own right, see Camaj and McKeever 2026) — makes the Ukrainian case a hard test for a category built for peacetime; virtual exchange has already been described as a working mode of internationalisation at a distance (Çalıkoğlu et al. 2024).

For one segment of the system the test is doubly hard. Military education is closed by definition: secrecy regimes, a departmental vertical, restrictions on contacts — all of it the opposite of the horizontal logic of networks. Yet the literature on epistemic communities shows that expert networks in the security domain are possible: Haas (1992) laid down the very framework of knowledge communities capable of shaping policy; Cross (2015) demonstrated their work inside EU security agencies; Libel (2016) applied the optic to national defence universities, where military and academic cultures are forced to negotiate. Still, the field of professional military education research — despite a tradition reaching back to the classic study by Masland and Radway (1957) — remains fragmented: a recent systematic review records the lack of a shared understanding of the subject and a near-absence of in-depth national case studies (Enstad and Hagen 2025). The junction of the two literatures — diaspora knowledge networks and the internationalisation of military education — is empty: neither asks whether a scientific diaspora can serve as a channel of internationalisation for the defence segment. The next subsection shows this emptiness quantitatively.

### *2.4. Mapping the field: trends and the structural gap*

We document the emptiness at the junction not declaratively but bibliometrically — with co-occurrence maps of author keywords built in VOSviewer from a cleaned Scopus corpus (12,101 records, 2012–2026, publications with russian affiliations removed; full counting, association-strength normalisation, a thesaurus of 60 merges and 48 removals).

The full-corpus map (Fig. 1) groups the field into five distinct blocks. The methodological core of network analysis and scientific collaboration sits next to the bibliometric toolkit; the social-capital block, home to collaboration, networks, trust, mentoring and human capital, holds apart; the fourth is the war block, where Ukraine, war, migration, refugees, resilience, mental health and higher education stand side by side. The position of brain drain is telling: it sits on the border between the war and social-capital blocks — exactly where our framework places diaspora networks. Military-education vocabulary, by contrast, forms no visible cluster on the field's map: terms such as military education gather neither the occurrences nor the links needed to break onto the shared map with diaspora and network vocabulary. The field simply does not see it.

The year overlay (Fig. 2) adds the temporal dimension. The youngest block on the map is the war block: Ukraine, war, refugees and mental health glow yellow (2023–2024), while the methodological core of network analysis and the social-capital vocabulary are the oldest (2020–2021). The field this article enters took shape within three or four years — which is precisely why its internal partitions have not yet had time to erode naturally.

The military subcorpus map (Fig. 3) confirms the gap from inside. Military education's own literature falls into three islands: the institutional core of professional military education; the digital-education backbone — digital education, security and defence education, distance learning, higher education, artificial intelligence, e-learning; and the training-simulation block of virtual reality, serious games and training. The year overlay shows that the field's freshest wave (2022–2023) is digitalisation and artificial intelligence, in line with the wider digital transformation of military education across NATO (Doicariu 2025). But neither the cluster map nor the density map contains a single term from the diaspora or network vocabulary: no diaspora, no mentoring, no social capital, no networks. The military-education literature modernises its teaching tools without noticing the human infrastructure that could feed that modernisation.

The year-by-year dynamics (Fig. 4) make the gap glaring. Publications at the junction of war, Ukraine and academia exploded after February 2022: six papers in 2021, sixty-two in 2022, one hundred and ninety-six in 2023 and two hundred and seventy-eight in 2025 — growth of one and a half orders of magnitude in four years. The higher-education-resilience line takes shape as a distinct theme from 2023 and climbs steeply through 2025–2026. The diaspora line is stable and also rises visibly after the invasion. Even military education grows — to twenty-four papers in 2025. But the fifth line, the intersection of military education with diaspora or network themes, lies at zero in every single year from 2015 to 2026. Not one publication in twelve years — while both literatures this intersection should connect keep growing. This is the quantitative portrait of the gap the article closes.

### *2.5. Synthesis: networked internationalisation under wartime immobility*

We draw these lines together into a working framework. Networked internationalisation under wartime immobility is a regime in which the international dimension of a country's education and science is sustained not primarily by the mobility of people or by inter-institutional agreements, but by the living tissue of displaced scholars' personal ties to their institutions of origin. The framework has four elements. Nodes — displaced scholars with a dual professional loyalty, empirically visible in dual affiliations. Ties — mostly weak bridges across the border: mentoring pairs, joint

applications, peer review, remote teaching; their value lies precisely in their non-redundancy, after Granovetter and Burt. Structures — chapters as communities of practice that convert brittle swift trust into durable trust, and a digital platform that lowers the cost of finding a tie. Boundaries — segments of the receiving system with different capacities to absorb what the network brings: the absorptive capacity (Cohen and Levinthal 1990) of a civilian university and of a military institute differs not for lack of need, but because of different secrecy regimes, personnel cycles and histories of international exposure.

The framework yields the article's empirical expectations directly. If the network truly works as an infrastructure of resilience, its ties should be oriented outwards, towards Ukraine, rather than closing inside the diaspora; its brokerage should concentrate in the hands of a small group of brokers on whom connectivity critically depends; mentoring pairs should bridge different clusters more often than form inside dense groups. And if the boundary with the military segment is structural rather than an accident of small numbers, a node's proximity to military education should reduce the probability of a tie even after the usual attraction factors — shared country, field, gender — are accounted for. These expectations are operationalised in hypotheses H1–H5 and tested in the results section; Fig. 5 summarises the framework.

## 3. Context and data

### *3.1. The case: the Ukrainian Science Diaspora initiative*

The initiative emerged in 2022 as the diaspora's own answer to a question the war posed point-blank: how can thousands of scholars scattered from Boston to Tokyo work for Ukrainian science without physically returning? Its core is a public scholars' map on the ukrdiaspora.nauka.gov.ua platform: a registry in which each participant states their country, field, institution and readiness for specific forms of cooperation. As of June 2026 the map unites 447 researchers across eighteen organisations and national chapters (Zbezhkhovska 2026a) — from countries with long-established academic diasporas to circles that formed only after the invasion. The network has a distinctly layered build: around the formal core of the map operates a communication periphery — a Telegram community of over 1,300 members and a LinkedIn audience of over 2,200 — so that for every scholar registered on the map there are two or three more in the active communication circuit and nearly five in the wider professional one. Infrastructure has grown up around the map: a mentoring programme — four completed three-month cycles, 37 mentors, 40 mentoring pairs, including a dedicated cycle for economists, with a fifth cycle starting in September 2026 — regular open chapter events, and partnerships ranging from MIT to line ministries and international donors (Polishchuk et al. 2023; Zbezhkhovska 2026a). For network analysis this structure is a rare gift: its ties are not reconstructed retrospectively from publications but recorded by the participants themselves at the moment of formation.

### *3.2. The landscape of wartime support networks*

The initiative does not operate in a vacuum. The war has produced at least four distinct network forms of support for Ukrainian science, and their juxtaposition is part of the study's design. The volunteer platform #ScienceForUkraine gathered over two thousand four hundred offers — positions, fellowships, access to infrastructure — from institutions in dozens of countries within weeks (Rose et al. 2026): a network of transactions rather than relationships. Fellowship schemes such as MSCA4Ukraine formalise support into fixed-term grant agreements. The twinning programme has connected over one hundred pairs of British and Ukrainian universities at the level of memoranda and joint activities (Cormack Consultancy Group and Universities UK International 2025). Each form has its own logic: who connects whom, how personal the ties are, who coordinates. Table 1 draws these differences together — and adds a fifth row that explains why military education requires separate treatment.

**Table 1. Network forms of support for Ukrainian science and education in wartime**

| Network form | Example | Whom it connects | Nature of ties | Coordination | Reach into military education |
|---|---|---|---|---|---|
| **Grassroots diaspora network** | Ukrainian Science Diaspora: a map of 447 scholars, 18 organisations, a mentoring programme | Scholars abroad ↔ colleagues and institutions in Ukraine | Personal; membership, mentoring pairs, joint projects | Chapter self-organisation + a digital platform | Isolated contacts; no systematic interaction |
| **Volunteer offer platform** | #ScienceForUkraine: >2,400 support offers | Foreign institutions | Transactional; positions, | Volunteer team, open database | No offers for military institutions |

| | | | | | |
|---|---|---|---|---|---|
| | | and scholars → Ukrainian scholars | fellowships, access | | |
| **Programmatic fellowship scheme** | MSCA4Ukraine and analogues | Donor → displaced scholars → host institutions | Formalised; fixed-term grant agreements | EU programme management | Military HEIs are not eligible institutions |
| **Institutional partnership** | UK–Ukraine twinning: 105+ university pairs | University ↔ university | Inter-institutional; memoranda, joint activities | Government/association framework | Civilian universities only; military HEIs outside scope |
| **Military segment (for comparison)** | NATO DEEP (>15,000 participants in 2024), JATEC (from 2025) | Defence ministries ↔ military HEIs | Institutional; programmes, courses, standards | NATO–MoD intergovernmental vertical | The sole channel of internationalisation; no personal network layer |

*Sources: Polishchuk et al. (2023); Rose et al. (2026); MSCA4Ukraine, Twinning and DEEP programme documentation; compiled by the author.*

### *3.3. Military education: internationalisation without a network*

The war has loaded Ukraine's twelve higher military educational institutions twice over: they must train officers for the front while retraining themselves — for new doctrines, new equipment, new experience that the front generates faster than any educational system can absorb. The international component of this transformation is developing rapidly, but through one type of channel only. The NATO DEEP programme, running with Ukraine since 2013, reached over fifteen thousand participants in 2024 — a severalfold increase on the pre-war level. In February 2025, JATEC — the joint Ukraine–NATO centre for analysis, training and education, the first of its kind — opened in Bydgoszcz. An audit of the military education system against Alliance standards is under way. All of this is institution-to-institution: programmes, courses, standards, working groups. In the terms of Table 1, the military segment has a well-developed fifth row and four empty ones: none of the personal network forms — neither the diaspora map, nor the offer platform, nor the fellowship schemes, nor the twinnings — reaches it systematically. The reasons for this divide — secrecy regimes, regulatory constraints, personnel specifics, or the mutual invisibility of two worlds — are what the qualitative part of the study clarifies; its scale and structure are measured by the quantitative part.

The study's data are described in section 4: the diaspora map registry as the basis of network analysis, triangulation datasets (an open dataset of scholarly migration trajectories, ORCID profiles, the chronology of the map's growth), the bibliometric corpus, and the survey and interview materials.

# 4. Methods

### *4.1. Design*

The study is built as a sequential mixed-methods social network analysis: the quantitative phase measures structure — who is connected to whom, where the clusters are, who holds the bridges; the qualitative phase explains mechanisms; integration happens at the level of interpretation, when participants' testimony is laid over quantitatively identified positions (Froehlich et al. 2020; for applications see Pantic et al. 2022; Orynbassarova 2025). The design is a single embedded case study with several units of analysis (Yin 2018). The unit of analysis is the tie, not the person: the research questions concern relationships, and standard survey designs with independent observations are unsuitable here.

### *4.2. Network formalisation*

The diaspora network is modelled as a weighted multiplex graph with a bipartite backbone:

$$G = (V_s \cup V_c,\ E) \tag{1}$$

where $V_s$ is the set of scholars and $V_c$ the set of chapters, institutions and countries; the edges form three layers — membership, mentoring pairs, documented collaboration. For person-to-person questions a one-mode projection through shared structures is used; A = [$a_{ij}$] is the adjacency matrix, $w_{ij}$ the weight as the multiplicity of shared contexts.

### *4.3. Structural measures*

Node activity is measured by normalised degree centrality, the mediating role by Freeman's betweenness centrality:

$$C_D(i) = \frac{k_i}{n-1}, \qquad C_B(i) = \sum_{s \neq i \neq t} \frac{\sigma_{st}(i)}{\sigma_{st}} \tag{2}$$

Brokerage potential is assessed through Burt's constraint — the less redundant a node's contacts, the more it sits on structural holes:

$$c_{ij} = \left(p_{ij} + \sum_q p_{iq} p_{qj}\right)^2, \qquad C_i = \sum_j c_{ij} \tag{3}$$

Communities are detected by modularity maximisation (the Leiden algorithm):

$$Q = \frac{1}{2m} \sum_{i,j} \left[a_{ij} - \frac{k_i k_j}{2m}\right] \delta(c_i, c_j) \tag{4}$$

The network's outward openness is measured by the Krackhardt–Stern index for the partition 'abroad — in Ukraine':

$$E\text{–}I = \frac{E - I}{E + I} \tag{5}$$

Brokerage between the three groups — the diaspora, civilian institutions in Ukraine, the military segment — is classified by Gould–Fernandez roles: gatekeeper, representative, liaison (Gould and Fernandez 1989). Centrality distributions are skewed, so descriptive statistics are reported as

medians with interquartile ranges (canonical treatments of the apparatus: Wasserman and Faust 1994; Borgatti et al. 2018). Binomial proportions are reported with 95% Wilson intervals; agreement of distributions across independent sources is tested with the $\chi^2$ criterion with Yates's correction; for zero observations, exact binomial probabilities under conservative reference proportions are given.

*Worked demonstrations of every measure — computed on the corpus term network of 74 nodes and 335 edges, with a full data-to-result substitution chain for each reported figure — are provided in Supplementary S3; the resulting values are summarised in Table 2b.*

### *4.4. Dyadic tie-formation model*

The probability of a tie within a pair of nodes is modelled by logistic regression on dyadic covariates:

$$P(a_{ij}=1)=\Lambda(\theta_1\,geo_{ij}+\theta_2\,field_{ij}+\theta_3\,gender_{ij}+\theta_4\,mil_{ij}+\theta_5\,mentor_{ij}) \tag{6}$$

where geo, field and gender capture homophily by country, discipline and gender; $mil_{ij}$ = 1 if at least one node is proximate to military education. Hypothesis H4: $\theta_4 < 0$. Because network observations are interdependent, significance is assessed by the MRQAP permutation procedure with double semi-partialling (Dekker et al. 2007), at least 2,000 permutations, exact p-values reported. Robustness is checked with an exponential random graph model with density, GWESP transitivity and group-effect terms.

### *4.5. Network robustness*

Fragility is assessed by a computational experiment: nodes are removed at random and in descending order of betweenness, the relative size of the giant component S(f) is tracked, and the degradation trajectories are compared with Schneider's integral index:

$$R=\int_0^1 S(f)\,df \tag{7}$$

*The demonstration on the term network (Fig. 6; full protocol in Supplementary S3) yields R = 0.459 under random losses against 0.219 under targeted ones: a network whose connectivity rests on a few brokers is twice as vulnerable to their targeted loss — the contrast H5 predicts for the diaspora network, where node removal means departure, burnout or security restrictions.*

### *4.6. Bibliometric mapping*

The field maps (section 2.4) were built in VOSviewer. Term link strength is normalised by van Eck–Waltman association strength, the layout minimises the weighted sum of squared distances under a mean-distance constraint, and clustering uses the unified quality function with resolution parameter γ:

$$s_{ij}=\frac{2m\,c_{ij}}{w_i\,w_j} \tag{8}$$

$$\min\sum_{i<j}s_{ij}\,\|x_i-x_j\|^2 \quad \text{s.t.} \quad \frac{2}{n(n-1)}\sum_{i<j}\|x_i-x_j\|=1 \tag{9}$$

$$V(c) = \sum_{i<j} \delta(c_i, c_j)\,(s_{ij} - \gamma) \tag{10}$$

Build parameters: author keywords, full counting, an occurrence threshold of 30 for the combined corpus (12,101 records, 2012–2026) and 2 for the military subcorpus (341), following the threshold logic for small subcorpora (Tsybenko et al. 2025); a thesaurus of 60 merges and 48 removals; the software version and actual thresholds are recorded in the figure captions and in Supplementary S2.

### *4.7. Data, qualitative component, ethics*

The civilian segment's mechanisms are studied through secondary analysis of the Ukrainian Science Diaspora initiative's materials: an online survey of 300 diaspora scholars (CAWI, 23 October – 25 November 2025; a combined non-probability sample — network recruitment, snowballing in the logic of respondent-driven sampling (Heckathorn 1997), open databases; quantitative analysis in SPSS and content analysis of open answers; voluntary, anonymous, GDPR-compliant — Ukrainian Science Diaspora 2025; Polishchuk and Pozniy 2025), a survey of 30 representatives of Ukrainian higher education institutions with open questions (February 2026; Polishchuk 2026), the mentoring programme's statistics (Zbezhkhovska 2026a, 2026b), and the published corpus of 34 in-depth semi-structured interviews with diaspora scholars (60–90 minutes each, September 2025; conducted by the research agency Info Sapiens for the initiative with GIZ support and published in full — Kostiuchenko et al. 2025). The corpus is analysed thematically as secondary qualitative data; since the interviews are published with participants' names, quotation in the article is by name, from the published volume. The registry's representativeness is checked against the open dataset of scholarly migration trajectories (Akbaritabar et al. 2024). The limitations of secondary data — self-selection and non-probability sampling — are acknowledged and offset by triangulation across three independently collected sources; the military segment, which these materials do not touch, is covered by the secondary use of the authors' own expert data, described below.

The study involves no new data collection from human participants. Evidence on the military segment comes from the secondary use of the general sections of an anonymous expert survey on the information environment of military education, conducted by the authors earlier within a related project (n = 12; an identifier-free profile — military HEI lecturers, information security specialists, managers, researchers; consent to the use of responses in aggregated form for research purposes recorded via a mandatory consent item preceding the questionnaire). The analysis covers the expert profile and open comments touching on international cooperation, exchange of experience and barriers; the survey's specialised blocks belong to a separate study and are not used here. Open comments are coded by reflexive thematic analysis (Braun and Clarke 2006); available scaled ratings are summarised by medians with interquartile ranges, and inter-expert agreement is tested with Kendall's coefficient of concordance W with a permutation-based p. The study deliberately does not touch classified domains: the absence of open personal network data for the military segment is a substantive property of the object, not a gap in the design. The relevant survey items are provided in the Supplementary Information; pseudonymised matrices, computation code (R: igraph, sna, ergm; Python: networkx; Gephi for visualisation) and mapping parameters are deposited in an open repository (DOI redacted for double-anonymised review and provided in the cover letter for editor and referee access).

# 5. Results

The results follow the three research questions. First, the scale and build of the diaspora network and the structure of the knowledge field it operates in (5.1); then the mechanisms through which the network sustains educational and research continuity (5.2); finally, the network's boundary — its military segment (5.3). Quantitative estimates rest on the initiative's public registry, the published surveys (n = 300 and n = 30), the mentoring programme's statistics and the bibliometric corpus; participants' voices come from the published corpus of 34 interviews and from the general sections of an expert survey in military education.

### *5.1. Anatomy of the network and the field*

As of mid-2026 the initiative's network unites 447 scholars and 18 organisations, and already at the structural level it does not reduce to geography: alongside fifteen national chapters operate two thematic networks that cut across countries, and an institutional partner; the only country with internal specialisation is Germany, with separate academic and business-science circles. Two-thirds of participants belong to the full-scale-war wave, three-quarters are women: the network is young in emigration terms and distinctly feminised, exactly along the asymmetric-immobility logic of section 2. Its most important property is dual presence: 30 per cent of respondents work for a Ukrainian institution remotely, another 38.3 per cent combine temporary positions abroad with collaboration at home, and only a quarter have settled abroad permanently. In the terms of hypothesis H2, the network is open towards Ukraine not metaphorically: a large share of its nodes stand institutionally with one foot at home. A direct reading of the public registry independently reproduces this picture: in the collected sample of profiles (n = 92, 21 per cent of the registry) the post-invasion wave makes up 62.7 per cent — against 66 in the survey (the difference is insignificant: $\chi^2(1) = 0.14$; $p = 0.71$); Germany and Poland head the geography, as in the survey; a quarter of profiles contain an explicit 'Ukrainian institution → host institution' pair; and 98 per cent of participants have a valid ORCID, which makes the network verifiable against external sources. The agreement of two independent cross-sections — a self-completed registry and a sampled survey — strengthens confidence in both. It can be traced down to individual trajectories: a participant of the mentoring initiative with British universities, one of the published interview collection's protagonists, Oksana Yarema, also appears in the map registry with the pair 'Ternopil Pedagogical University → University of Portsmouth' — one and the same node independently visible in three layers of data.

**Table 2. Structural characteristics: the initiative's network (a) and the field's term network (b)**

| Indicator | Value | Source / method |
|---|---|---|
| **a. The initiative's network (people and structures)** | | |
| Registered scholars / member organisations | 447 / 18 | public registry; network page |
| Typology of organisations: geographic chapters / thematic networks / institutional partners | 15 / 2 / 1 | author's classification of organisation profiles |
| Departure wave: after / before 24 Feb 2022 | 66% / 34% | survey, n = 300 |
| Women among respondents | 74% | survey, n = 300 |
| Dual presence: remote work for a Ukrainian institution / temporary position abroad / fellowship or grant | 30% / 38.3% / 18.3% | survey, n = 300 |
| Participation in support activities / willingness to join recovery | 91.3% / 93% | survey, n = 300 |

| b. The field's term network (knowledge structure) | | |
|---|---|---|
| Nodes / edges / density / components | 74 / 335 / 0.124 / 1 | Scopus corpus of 12,101; association strength |
| Degree centrality: median (IQR) | 0.068 (0.055–0.164) | equation (2) |
| Betweenness centrality: median (IQR) | 0.0006 (0.0001–0.0070) | equation (2) |
| Betweenness share of the top decile | 74.1% | H1: core–periphery structure |
| Leiden communities / modularity Q | 6 / 0.541 | equation (4) |
| E–I index of the military-education term group | +1.0 (I = 0; only 3 external edges) | equation (5); H4 |
| Robustness: R under random / targeted losses | 0.459 / 0.219 | equation (7); H5; Fig. 6 |
| Giant component falls below 50% | at 23% targeted vs 47% random removals | percolation experiment |

*Sources: the initiative's public registry and pages; Ukrainian Science Diaspora (2025), n = 300; author's computations on the Scopus corpus (12,101 records, 2012–2026). Equation numbers follow section 4.*

Panel (b) of Table 2 moves the analysis to the level of the knowledge field the network operates in. The corpus term network confirms the core–periphery structure typical of young research fields: seven top-decile nodes concentrate 74.1 per cent of all betweenness (H1), and the Burt constraint of the principal brokers — 0.09–0.18 — shows they do sit on structural holes between six Leiden communities. The percolation experiment (Fig. 6) adds the fragility dimension: under targeted removal of the top brokers the field loses half its connectivity at only 23 per cent of removals — twice as fast as under random losses (Schneider indices 0.219 against 0.459; H5). For a network whose brokers are living people under the pressure of war, displacement and burnout, this is not an abstraction but a vulnerability map.

### *5.2. Mechanisms of continuity*

What flows through the network's ties is shown by juxtaposing the two surveys. Practised forms of support (Fig. 7a) are headed by joint publications and conferences — forty-nine per cent each, roughly one hundred and fifty people apiece; then promotion of Ukrainian science abroad (40.3), online teaching (35.7), joint grant applications (32), advising junior colleagues (31.3). This is, in effect, the inventory of weak cross-border ties from section 2.2, measured in people. Participation in supporting Ukraine is declared by 91.3 per cent of respondents, willingness to join the recovery by 93.

The most telling finding is the mirroring of barriers (Fig. 7b). Seven of the eight obstacles the diaspora names most often — from poor communication with Ukrainian institutions (62.7 per cent) and the lack of state engagement mechanisms (55.3) to the absence of a coordination platform (28) — have a direct counterpart in the categories through which university representatives describe the problem: communication gaps, no systemic policy, no coordinators or internationalisation offices. Neither side sees the problem in the other — both see missing connective tissue. The summary of the university survey states the demand precisely: participants are not asking for more lectures; they want the diaspora institutionally integrated into university development — structured interaction instead of one-off events.

The mentoring programme is a rare case where the conversion of a tie into an outcome can be counted (Table 3, Fig. 8). The initiative's communication ecosystem narrows in layers: over 2,200

LinkedIn followers, over 1,300 Telegram chat members, 447 registered on the map, 40 mentoring pairs across four three-month cycles in 2024–2026 — and 19 documented outcomes of those pairs. Every second pair produced a measurable result (a conversion of 48 per cent; 95% Wilson interval 33–63), every eighth a publication. Pairs per mentor stand at 1.08: brokerage in the programme is distributed rather than concentrated, meaning the mentoring tissue does not reproduce the field's core–periphery build — a strength from the robustness point of view. A documented case of one pair shows the compounding mechanism: a mentoring tie formed in 2024 grew, step by step, into a Scopus-indexed paper, selection for an MIT programme and a three-year national grant project. The interview corpus adds a critical edge to mentoring as well: Sereda warns that in unequal partnerships Ukrainian researchers 'often become merely a source of information supply' described and published by someone else — co-authorship with a 'star' brings visibility but slides easily into supplying data without authorship. For the design of mentoring programmes this argues for fixed co-authorship rules, as in the initiative's own programme.

**Table 3. The 'Science Diaspora for Ukraine' mentoring programme: scale and documented outcomes**

| Mentoring programme indicator | Value |
|---|---|
| Mentors / mentoring pairs / three-month cycles (2024–2026) | 37 / 40 / 4 |
| Pairs per cycle / pairs per mentor | 10 / 1.08 |
| Documented pair outcomes, total | 19 |
| — published papers | 5 |
| — academic exchange applications | 6 |
| — CVs updated to European standards | 6 |
| — international cooperation agreements | 2 |
| Conversion 'pair → documented outcome' | 48% |
| Share of pairs with a published paper | 12.5% |

*Sources: Zbezhkhovska (2026a, 2026b); author's computations.*

The published corpus of 34 interviews unfolds these frequencies into mechanisms — and into tensions invisible in questionnaires. The logic of horizontal ties is put by Gorodnichenko: official offers often run into 'what can you know, you don't live in Ukraine', whereas grassroots ties — when you know someone personally and help their students — work far more effectively. Keudel names the missing link outright: for a hundred fellowship alumni with expertise gained abroad 'there are simply no interfaces' — no windows in the ministries capable of receiving that knowledge; she sums up the diaspora's own fragmentation with the proverb 'two Ukrainians — three hetmans', and links the successful exceptions to institutionalisation. Sereda rejects the very word 'diaspora': she never interrupted her work in Ukrainian institutions — the dual presence that the quantitative data record as 30 per cent remote work is experienced from inside not as emigration but as a Ukrainian career stretched between countries. The initiative's own primary research adds a segmentation important for interpretation: the post-2022 wave should not be expected to bring large institutional resources, but its motivation is exceptionally high — the network runs on motivation rather than accumulated positions, which is why its main mechanisms are light, personal and low-budget, a pattern consistent with wave surveys of Ukrainian scholars in wartime (Lutsenko et al. 2023, 2025).

### *5.3. The network's boundary: the military segment*

The nature of the gap determines which questions can properly be asked. A large part of the information space of military education operates under state-secret and restricted-information regimes: an open personal network with public profiles, like the diaspora map, is impossible for this core by definition — and no research or intervention should encroach on it. The empty cell in the typology of section 3 is constitutive, not pathological, in nature. The article's question is therefore not 'why is military education not in the network' — there the answer is trivial — but where the non-classified boundary runs and how far the open side of it is used: guest lectures, mentoring on non-classified topics, joint publications in open journals, review of study programmes.

The diaspora's own discourse is eloquent here: in the published corpus of thirty-four in-depth interviews, military education is not mentioned once — against detailed discussions of mentoring, grants, gender equality and recovery. The only two adjacent remarks merely underline the asymmetry, and one of them reverses the usual direction of transfer: it is to Ukrainian military medics, Kuzemska notes, that people now come to learn, not the other way round. The open band along the secrecy boundary, then, does not merely exist — it already works, so far mostly in the export direction.

The available data give a concordant answer to the question: the open band is almost empty. Bibliometrically — across twelve years the corpus contains not a single publication at the intersection of military education with diaspora or network themes, and this is no artefact of a small field: both literatures grow separately, and publications on the war and Ukrainian academia rose by one and a half orders of magnitude after 2022 (Fig. 4). Structurally — on the field's map, military-education terms hold on by three edges, all of them external: the E–I index for this group equals one with zero internal ties — military-education vocabulary lacks even its own connectivity, let alone bridges to the diaspora vocabulary (Table 2b). Institutionally — none of the four network forms of Table 1 reaches the military segment: the #ScienceForUkraine database holds no offers for military institutions, military HEIs are not eligible institutions of the fellowship schemes, and the twinnings connected civilian universities only. And finally, the registry itself: in the collected sample of map profiles (n = 92), among the Ukrainian institutions of origin — from national universities and NAS institutes to sectoral centres — there is not a single higher military educational institution or defence-sector body; the only security-adjacent institution is an interagency centre for combating organised crime. Even at a conservative share of military institutions in the higher education system (three to five per cent), the probability of meeting none in 92 profiles would be just 0.9–6.1 per cent — the zero in the registry does not look like sampling accident.

The diaspora survey shows this gap to be the limiting case of a wider pattern. About two-thirds of respondents are willing to act as experts for government bodies in the recovery, yet it is precisely the policy-institutional channel that remains the network's weakest function: the expertise exists; the pathways from it into state structures do not. Where a tie requires no more than a horizontal agreement between two people, the network works; where it requires a formal channel into a departmental vertical, it stops — for civilian ministries such channels are at least being designed, for the defence establishment even the conversation about them has not begun.

The general sections of the expert survey in military education (n = 12; military HEI lecturers, information security specialists, managers and researchers with at least five years in the field, most

with practical experience inside the defence system) show how this boundary looks from within. Two touches are telling. Agreement among expert assessments of the new challenges is low: Kendall's concordance coefficients across five assessment categories lie in the range 0.04–0.26, with only one reaching significance ($W = 0.258$; $\chi^2 = 9.27$; $p = 0.026$) — the professional milieu has not yet formed a shared frame of judgement on the challenges of digital transformation, and that is exactly the state in which external expertise and horizontal peer exchange are most valuable. At the same time, the countermeasures the experts rank highest — verification checklists (feasibility 3.91, effectiveness 3.92 on a five-point scale), training scenarios, competence assessment — are non-classified by nature: source-verification and social-engineering-recognition methods are open competences that diaspora expertise possesses and that can be transferred without touching restricted domains at all. Notably, the survey instruments themselves build the state-secret and restricted-information regimes into the assessment of consequences: the secrecy boundary is an operational reality of the sector, not an external assumption of this article. Together this evidence closes the pattern: international interaction exists as an institutional channel and barely exists as a tissue of personal ties — even though the segment's most acute methodological needs lie precisely in the open band.

# 6. Discussion

### *6.1. The network as a regime of internationalisation: what the Ukrainian case adds*

The category of internationalisation at a distance was built for a world in which distance is an inconvenience: the student cannot come, so education travels to them through a digital channel (Mittelmeier et al. 2020; Bruhn-Zass 2021). The Ukrainian case inverts the terms of the problem. Here distance is not chosen — it is imposed by the legal regime of martial law, and imposed asymmetrically: female scholars crossed the border and lost institutional anchoring, men kept their institutions and lost mobility. Under such conditions the network ceases to be one channel of internationalisation among several and becomes its only working regime. Our results show that this regime has an architecture of its own: dual presence as a mass practice (a third of the network works for Ukrainian institutions remotely, another third and more combine temporary positions abroad with collaboration at home), a measurable conversion of ties into outcomes (every second mentoring pair, every eighth producing a publication), and a mirroring of barriers on both sides of the border that points not to a deficit of will but to missing connective tissue. This allows us to speak not of a metaphor but of a measurable construction — networked internationalisation under wartime immobility — with predictable points of strength and fragility. Why this construction needs a designed platform is explained by a generational comparison in the interview corpus: a quarter of a century ago, the few scholars abroad clustered by themselves, because around them was a vacuum; today, in Goncharov's words, 'there is no such magnet any more' — attention is dispersed, and the role of natural gravity has to be taken over by digital infrastructure.

The second theoretical shift concerns the diaspora itself. The literature on diaspora knowledge networks described them as transfer channels (Meyer 2001; Saxenian 2006); our material shows a structure that behaves rather like an epistemic community in the making (Haas 1992) — with its own norms of reciprocity, the swift trust of virtual teams (Jarvenpaa and Leidner 1999) and chapters working as communities of practice (Wenger 1998). The difference is not terminological: a channel can be opened and closed, whereas a community accumulates collective identity and a capacity for concerted action — and it is this capacity that explains how, in four years, the network grew from followers into a structure of eighteen organisations, a mentoring programme with documented outcomes, and its own research cycle — three surveys and a published interview corpus about itself.

### *6.2. A comparative mirror: four trajectories of scientific networks under pressure*

The Ukrainian case gains from juxtaposition with three others unfolding almost simultaneously. In Israel after October 2023, international scientific ties came under the pressure of boycott sentiment — and the data show a visible cooling of collaborations, compensated by internal cohesion and diaspora networks (Hager et al. 2025). Russian science displays the vector opposite to Ukraine's: networks do not mobilise but disintegrate — emigration without diaspora consolidation, severed institutional partnerships, an isolation deepened by the state itself (Zhang et al. 2024; for digital traces of the developer outflow see Wachs 2023). A similar logic of survival without institutional hinterland has been described for higher education in Gaza (Junina 2025). The Syrian case offers the longest horizon: more than a decade after the collapse of the academic system, scholars in exile have still not formed a network capable of working systematically for the country of origin —

support has remained fragmentary, dependent on host institutions (Akkad and Kohstall 2025; Parkinson 2022). Against this background the Ukrainian pattern — rapid grassroots consolidation with a preserved orientation towards home — looks not like a natural consequence of war but like the result of a conjunction of conditions: a digital platform, a critical mass of simultaneously displaced scholars, a century-old tradition of diaspora self-organisation and, crucially, the survival of working institutions in Ukraine to which knowledge can be returned. The Syrian mirror warns that none of these conditions is eternal, and the window in which the network can be institutionalised is measured in years, not decades. Ukrainian history has a precedent of its own: most scholars of the post-war emigration who found themselves in West Germany left for overseas after 1949 — an experience Portnov points to directly, cautioning against premature conclusions about the maturity of the new Ukrainian–German scholarly milieu (Kostiuchenko et al. 2025).

### *6.3. Closing the last segment: designing network interventions*

The gap with military education has a hard core that no design can touch: classified domains remain outside any open network by definition, and an honest framework must acknowledge this rather than promise 'bridging'. The design task is narrower and more real: to populate the non-classified band along the boundary — today almost empty even though no security obstacle stands in it: not a single publication at the intersection of the literatures in twelve years, zero internal connectivity of military-education vocabulary on the field's map, not one military HEI among the institutions of origin in the collected registry sample, and not one mention of military education in thirty-four in-depth diaspora interviews. Valente's (2012) typology of network interventions suggests four levels of work: strengthening individual nodes, laying new ties, changing group structures, or shifting norms. Our data allow each level to be specified. Nodes: in the civilian network the brokers are already documented — coordinators of member organisations who are simultaneously present in the map registry as researchers hold the community–platform tie personally; for the military band their natural counterparts are diaspora scholars with defence expertise and military HEI lecturers with regular experience of international programmes, people already sitting on the boundary of two worlds. The percolation analysis warns what dependence on such people costs: under targeted loss of brokers the field's connectivity falls twice as fast as under random losses ($R = 0.219$ against 0.459; the half-connectivity threshold at 23 against 47 per cent of removals; Fig. 6), so an intervention must duplicate brokers, not merely use them. The design must also absorb a lesson the diaspora learned in civilian partnerships: donor formats of 'one university there — one here' preserve institutional divides and cannot accommodate network projects of fifteen or twenty institutions (Sereda, in Kostiuchenko et al. 2025) — a network intervention cannot be designed on a bilateral template. Ties: the formats with the lowest security threshold — open guest lectures, mentoring of doctoral candidates on non-classified topics, joint publications in open journals — allow trust to be built without touching restricted regimes; and it is in this band, as the expert survey shows, that the segment's most acute methodological needs lie — verification methods, training scenarios, competence assessment (section 5.3). Structures: the diaspora's chapter model suggests the format of a 'defence chapter' — a thematic community of practice aggregating the diaspora's dispersed defence expertise the way national chapters aggregate geography. Norms: the slowest level — the mutual visibility of two worlds, which today is absent even at the level of the literature.

The absorptive capacity of the receiving side (Cohen and Levinthal 1990) is the condition without which no intervention will work: a network can bring knowledge only to where someone can recognise and assimilate it. Tellingly, the initiative itself arrived at the same conclusion empirically: for diaspora help to be effective, one must know how to receive it — the work belongs to both sides (Polishchuk and Pozniy 2025). A practical vocabulary for the tie level has already been worked out in recommendations for civilian universities — digital ambassadors, research volunteers, research liaisons, honorary researchers as formats of affiliation retention — and it is precisely the non-classified band — guest lectures, mentoring on open topics, joint publications, programme review — that is the natural place for its adaptation to military HEIs. The design principle comes from the participants' own experience: the most valued instruments are those with the lowest entry threshold, like the emergency grants of the Shevchenko Scientific Society in the US, where 'the application is short and the money arrives quickly'; and the proven formats of institutional internationalisation — double degrees and the joint teaching of a single course by a Ukrainian and a foreign lecturer — adapt to non-classified disciplines without any restricted-regime questions at all. Here the institutional dynamics of recent years work in favour of the network scenario: DEEP has accustomed military HEIs to international interaction, JATEC has created a legitimate meeting ground for the academic and military cultures, and the NATO-standards audit sets a language both sides understand. The institutional channels, in other words, have already prepared the soil on which a personal network could grow — what is missing is the graft itself. If coalition formats of support for Ukraine (House of Commons Library 2026; NUPI 2026) develop in the educational direction, the network layer should be designed into them from the start rather than added after the fact.

### *6.4. Limitations and next steps*

Honesty requires drawing the boundaries of what has been said. The diaspora map covers the active, self-organised part of the scholarly emigration — those who registered; the silent majority remains outside the analysis, and our estimates of openness and connectivity concern the network, not the diaspora as a whole. Self-selection also operates at the level of the qualitative data: those who answered were those with something to say about cooperation. Dual presence, which we record as the network's strength, also has a price and is not available to everyone: some displaced female scholars were given a 'return or resign' choice by their Ukrainian institutions, others carry the double load of two unrelated jobs — so the thirty per cent of remote work for Ukraine should be read as the outcome of a selection of those whom institutions allowed to stay connected. The military segment has been studied exclusively on open data and voluntary testimony — by definition the visible part of the iceberg. The network cross-section is static: we see the architecture as of mid-2026, not its evolution; a panel repetition of the measurement in a year or two would turn the snapshot into a film and allow a test of whether the network institutionalises or burns out — the Syrian scenario makes that question far from rhetorical. And finally, one case, even with a comparative mirror, licenses no universal claims: our framework is an offer for testing on other wartime and post-war systems — from Sudan to, one day, the post-war reconstruction of Ukraine itself.

## 7. Conclusions

To the three questions posed at the outset, the article gives three answers. The network of the Ukrainian scientific diaspora is neither a metaphor nor a mailing list: it is a measurable construction of 447 scholars and 18 organisations of three distinct types — feminised, born mostly of the full-scale war's wave, and massively dual-present, with a third of its nodes standing institutionally with one foot at home. It works through mechanisms that can be counted: every second mentoring pair yields a documented outcome, every eighth a publication, and the main obstacle — named independently and in mirror image on both sides of the border — is not a deficit of will but the absence of connective tissue between a motivated diaspora and overloaded institutions. The military segment stays outside the network for two different reasons, which the article deliberately keeps apart: the classified core is closed constitutively, and no intervention should encroach on it; but the non-classified band along the boundary — guest lectures, mentoring on open topics, joint publications, programme review — is empty for no security reason at all, and four independent sources record that emptiness unanimously.

Theoretically, the Ukrainian case extends the category of internationalisation at a distance into a regime of networked internationalisation under wartime immobility — one in which personal ties become not a channel of the international dimension but the only channel available to segments locked in place by war. Practically, the civilian segment's experience hands military education a ready, tested vocabulary of low-threshold formats, and the institutional channels of recent years have already prepared the soil for a personal layer. The time horizon is set not by theory but by history: the Syrian case and Ukraine's own experience of the post-war emigration both warn that the window in which such a network institutionalises is measured in years. The network that today holds Ukrainian science together at a distance is an infrastructure built largely by women's hands over four years of war; whether the system learns to receive what that infrastructure can deliver — including to its most closed segment — is no longer a research question but a governance one.

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## Figure legends

Fig. 1. Keyword co-occurrence map of the full corpus (VOSviewer): the methodological core of network analysis, the bibliometric toolkit, the social-capital cluster (collaboration, networks, trust, mentoring, human capital), and the war cluster (Ukraine, war, migration, refugees, resilience, mental health, higher education). Node size — occurrences; colours — clusters.

Fig. 2. The same graph with a mean-publication-year overlay (scale 2020–2024): yellower tones mark more recent literature.

Fig. 3. Map of the military subcorpus (341 records, occurrence threshold 2): the professional military education core, the digital-education backbone (digital education, security and defence education, distance learning, artificial intelligence, e-learning), and the training-simulation block (virtual reality, serious games, training).

Fig. 4. Annual dynamics of five thematic groups in the corpus, 2015–2026 (frequency analysis). The vertical band marks the full-scale invasion. The intersection 'military education × diaspora/networks' equals zero in every year.

Fig. 5. Networked internationalisation under wartime immobility: displaced scholars (nodes) sustain the education and science of the country of origin through weak cross-border ties — mentoring, co-authorship, dual affiliations — organised into communities of practice on a digital platform. The dashed boundary marks the military segment: the classified core is constitutively closed; the non-classified band is open but almost empty (hypotheses H1–H5 are marked next to the corresponding elements). Source: author.

Fig. 6. Percolation experiment on the corpus term network (74 nodes): giant component size S(f) under random (blue) and targeted (warm) node removal. The shaded area marks the robustness gap; the dotted line is the S = 0.5 threshold.

Fig. 7. Secondary analysis of the diaspora member survey (n = 300, October–November 2025): a — forms of cooperation with Ukrainian institutions; b — barriers to more active participation. Asterisks mark barriers with a mirrored category in the responses of higher education institution representatives (n = 30, February 2026). Sources: Ukrainian Science Diaspora (2025); Polishchuk (2026); visualisation by the author.

Fig. 8. Engagement layers of the network as of June 2026: from followers to documented outcomes of mentoring pairs. Source: Zbezhkhovska (2026a); author's computations.

# Figures

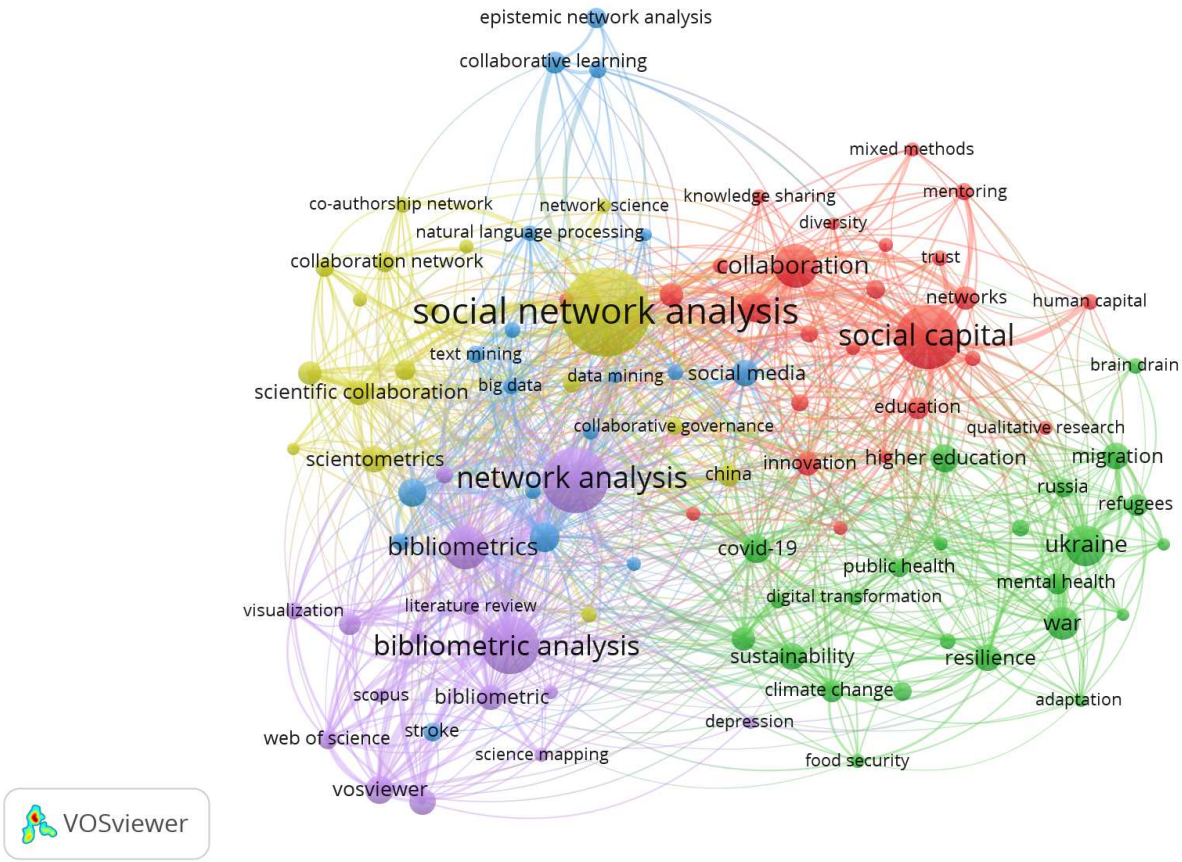



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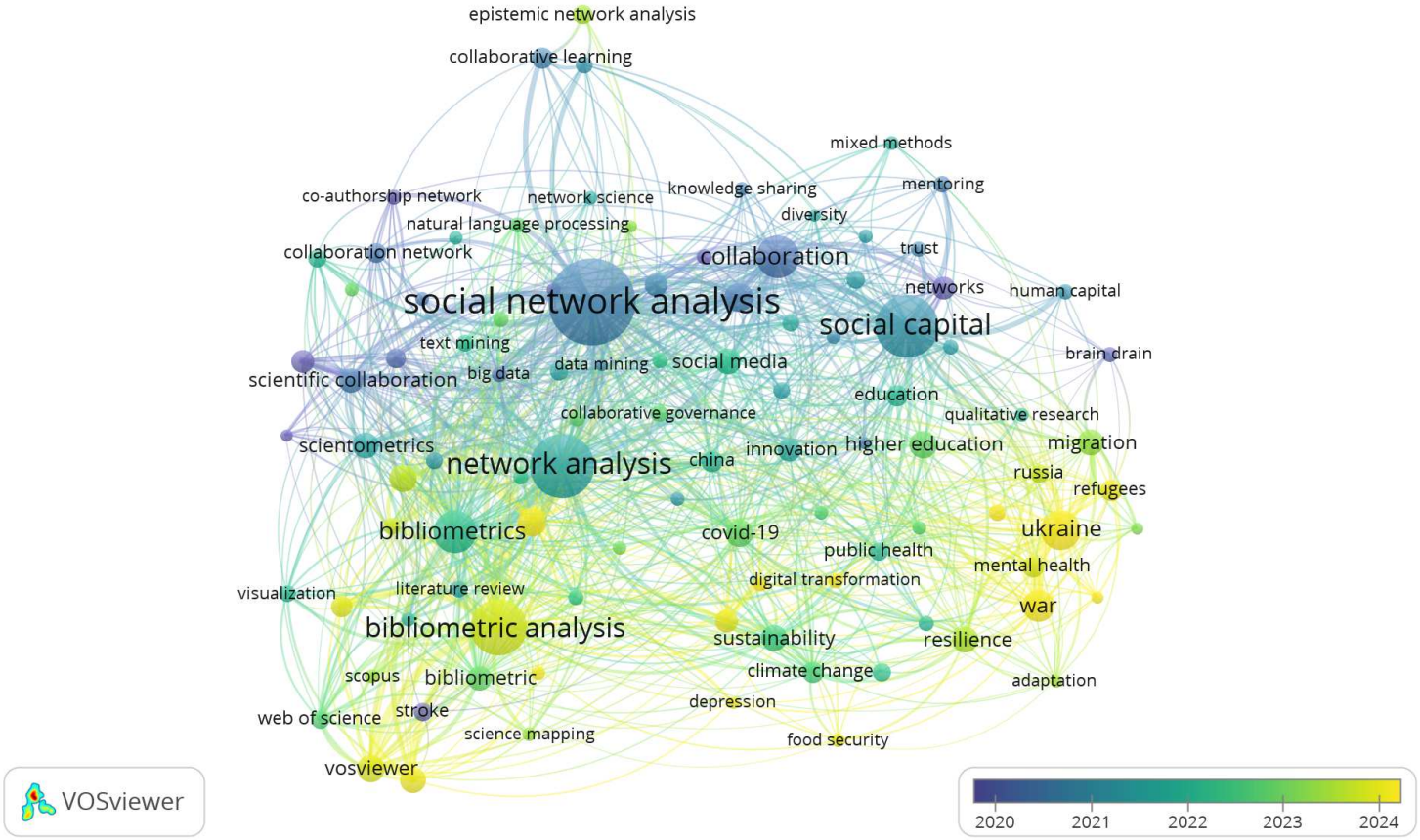



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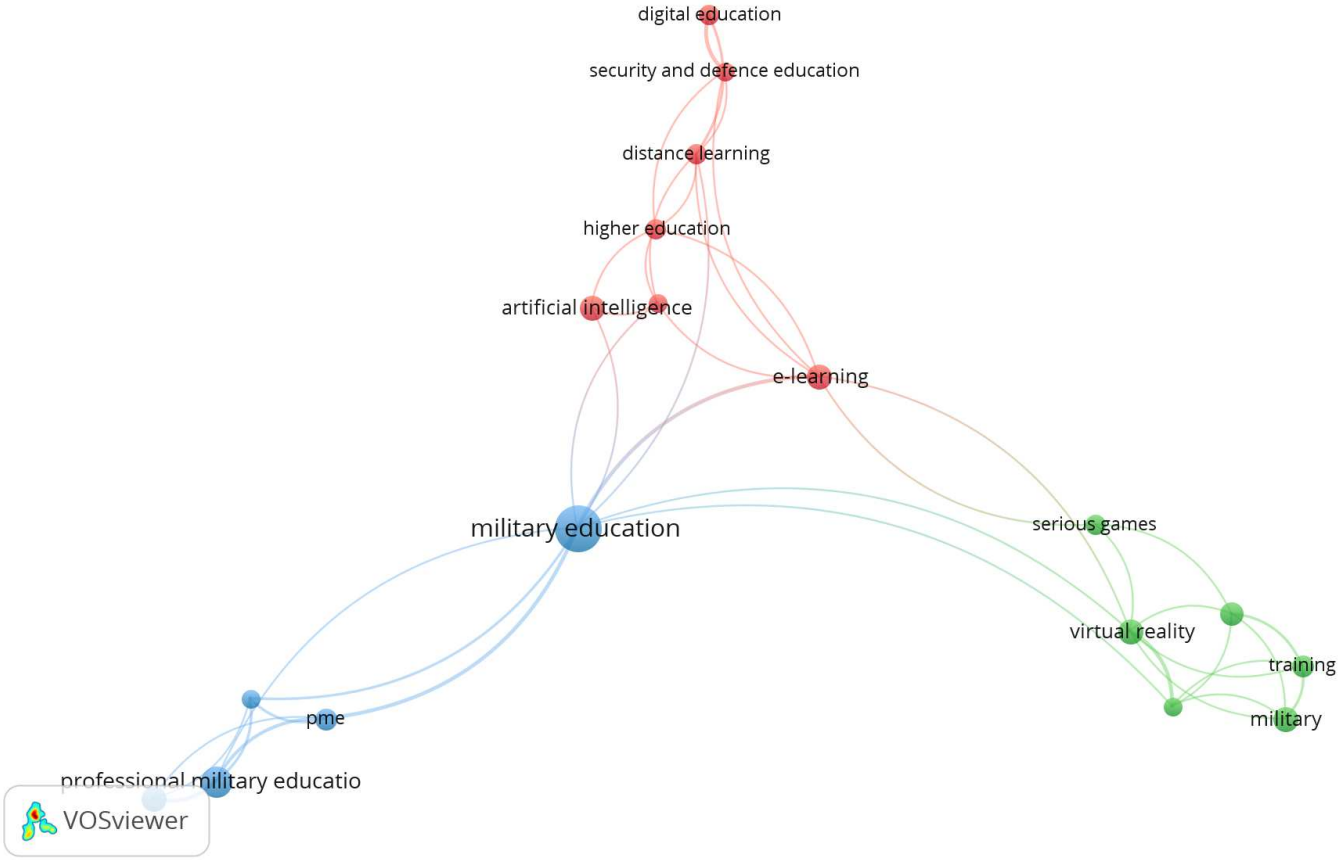



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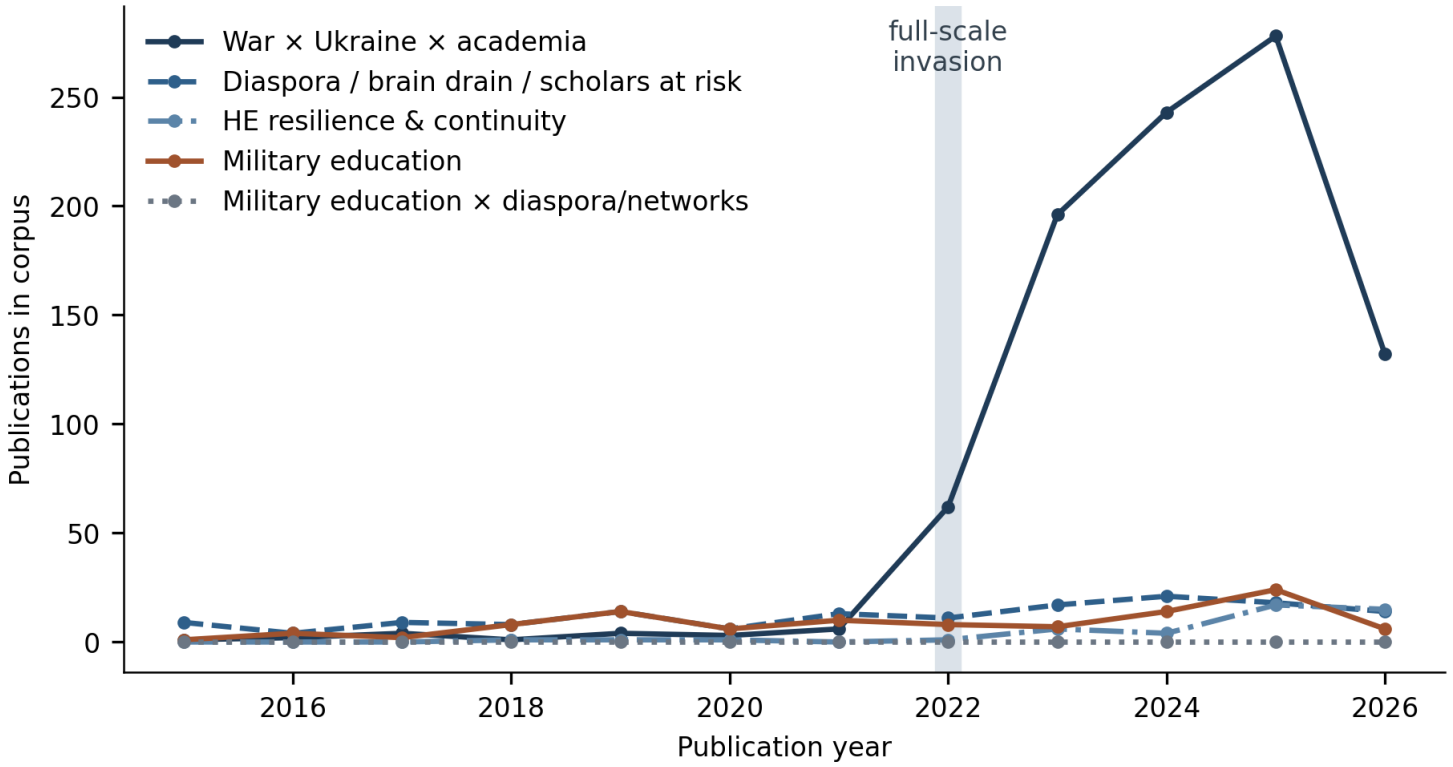



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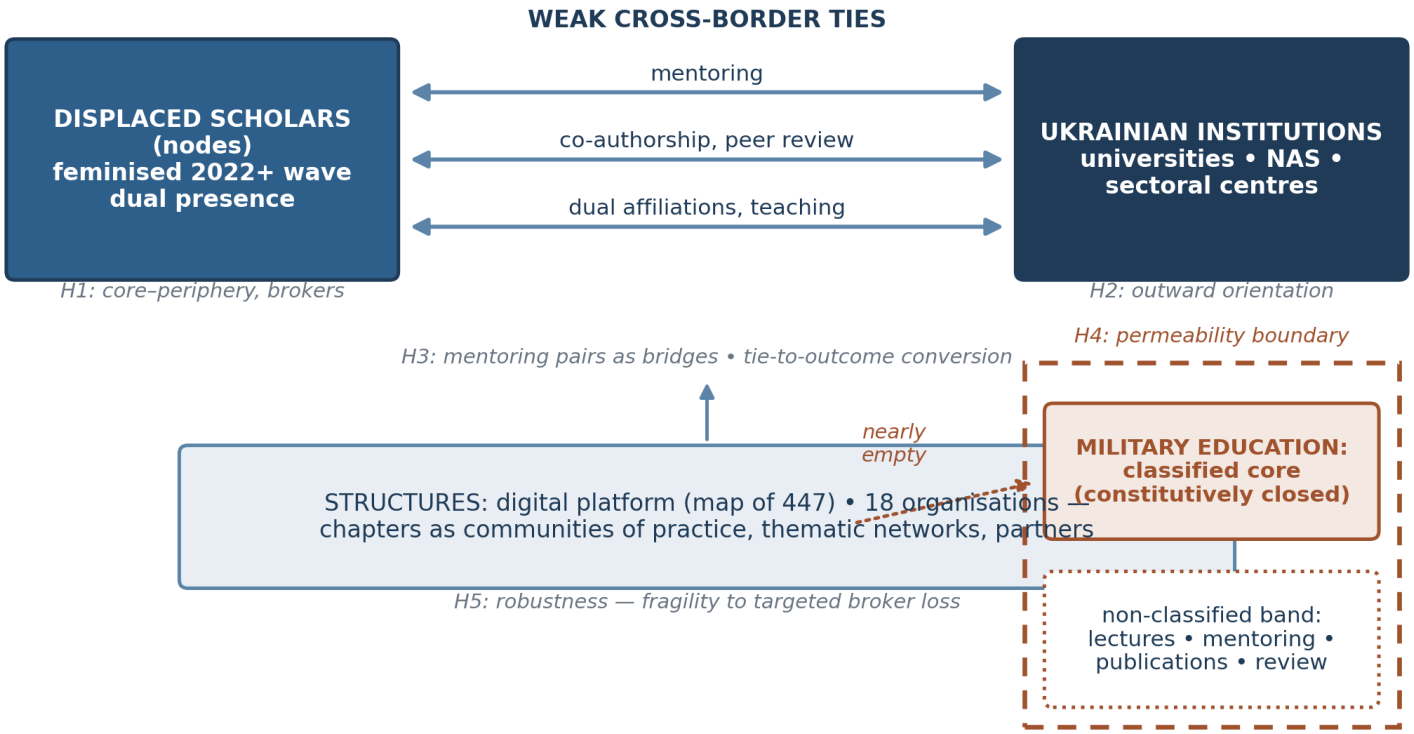



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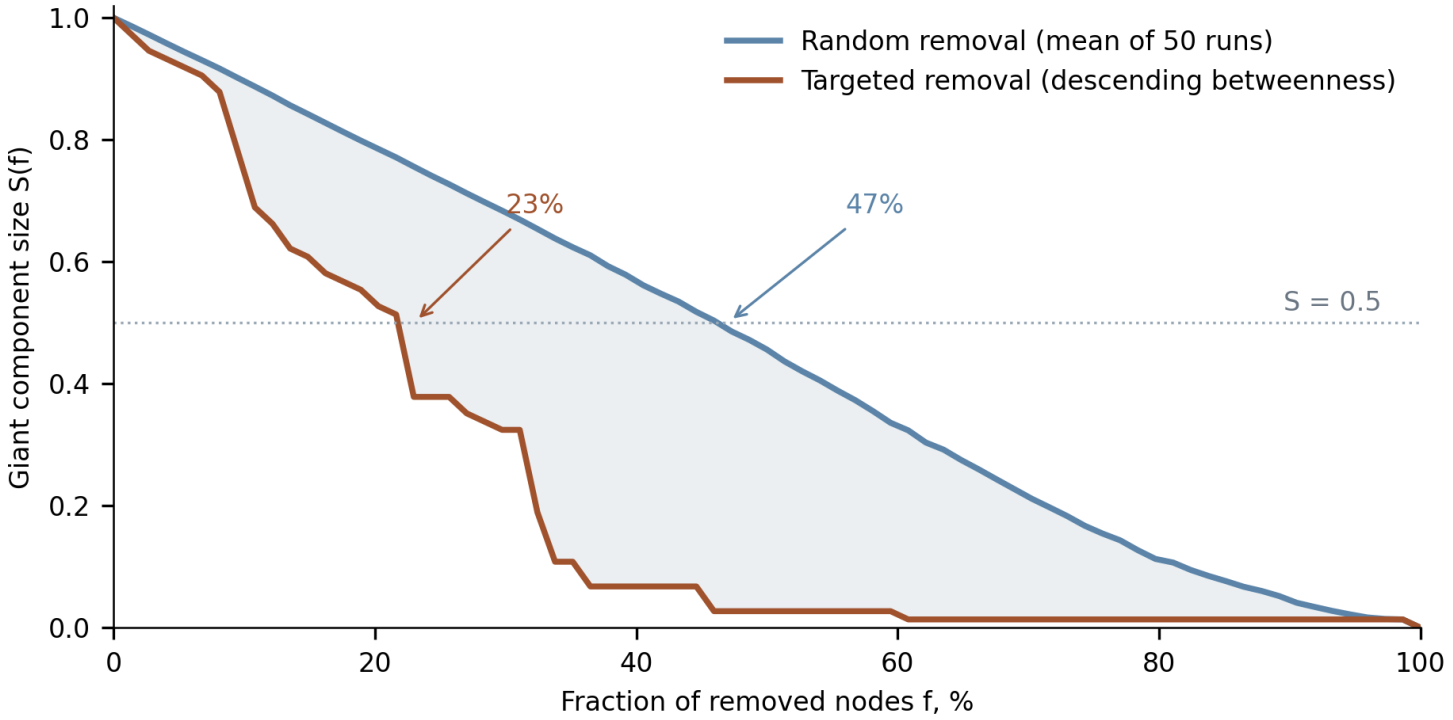



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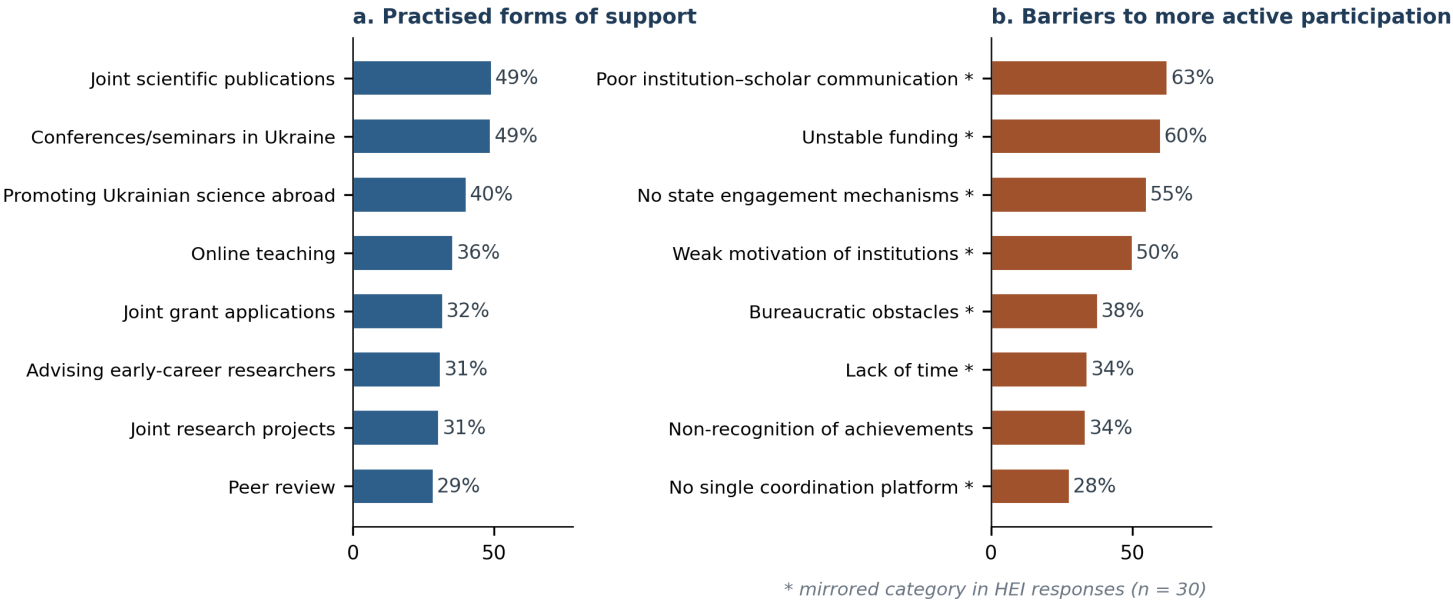



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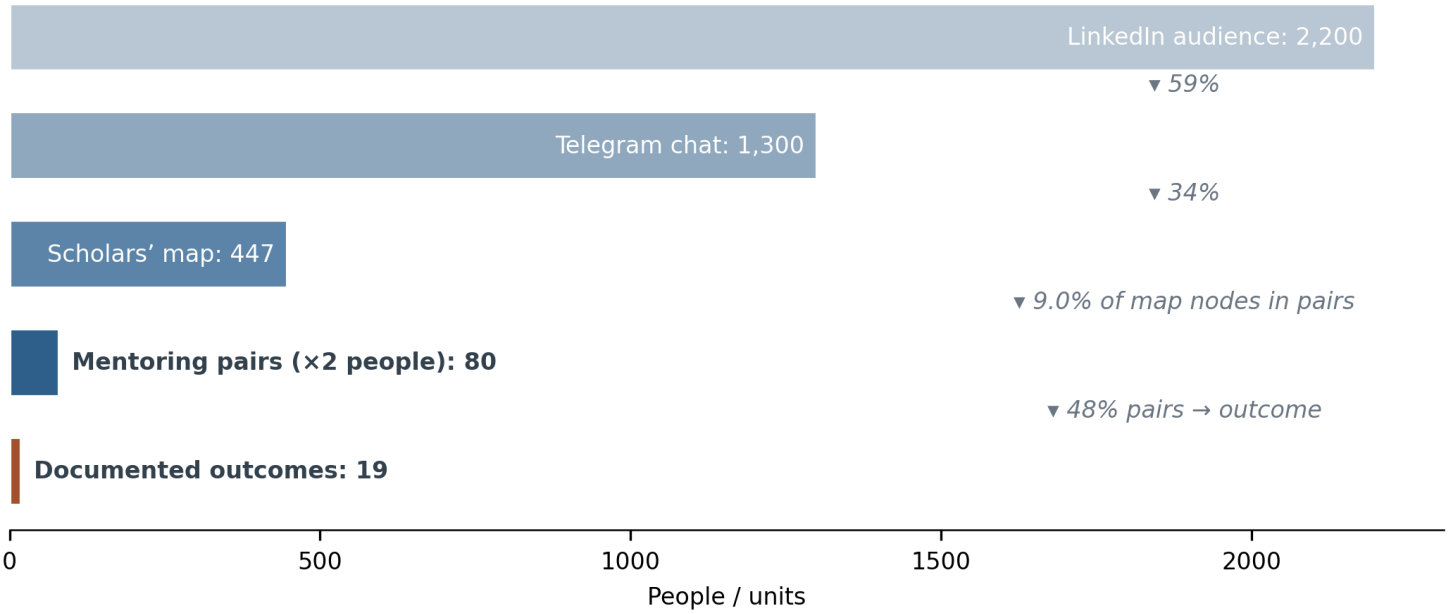



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