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Technology-Enhanced Learning in Humanitarian Emergencies: Promise and Risks

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Abstract: **Technology-enhanced learning (TEL) in humanitarian emergencies offers substantial potential to preserve learning continuity, deliver psychosocial support, and sustain workforce training where formal systems are disrupted. TEL modalities encompass a wide range of solutions from low-tech radio and SMS to high-tech online platforms, mobile applications, offline-capable resources, and blended models that combine digital and in-person facilitation. In emergency contexts such as armed conflict, mass displacement, natural disasters, and global pandemics including COVID-19, TEL can increase reach, enable rapid curriculum adaptation, and support monitoring and credentialing when physical infrastructure is compromised. However, TEL also introduces significant risks that must be managed: exacerbating digital divides, exposing vulnerable populations to surveillance and data breaches, creating dependencies on fragile infrastructure, and diverting limited resources from community-led non-digital responses. This paper synthesizes the literature on TEL in crisis settings, examines practical modalities and their comparative advantages, analyzes ethical, protection, and equity concerns, and presents illustrative examples of training students and employees during the COVID-19 pandemic and conflict-affected environments. Recommendations emphasize layered modality design, data-minimizing practices, community partnership and capacity building, inclusive technology design, contingency planning, and integration of psychosocial support. The paper concludes with a research and policy agenda to strengthen the responsible deployment of TEL in humanitarian settings, urging rigorous but context-sensitive evaluation approaches and sustained funding for resilient, locally led solutions.**

Keywords: **technology-enhanced learning; education in emergencies; digital learning; data protection; COVID-19; low-tech solutions; blended learning; psychosocial support; displaced learners; workforce training.**

1. INTRODUCTION

Humanitarian emergencies disrupt education and workforce training at scale, threatening both immediate learning trajectories and long-term human capital development; within these contexts, technology-enhanced learning (TEL) has emerged as a prominent strategy to mitigate disruption and maintain continuity of training for students and employees. TEL is defined broadly to include radio and SMS systems, mobile learning applications (native and web-based), offline digital content distributed on memory cards or local servers, synchronous virtual classrooms, learning management systems (LMS), and blended approaches that pair technology with in-person facilitation. The introduction of TEL in crises responds to multiple operational pressures: the need to reach geographically dispersed or mobile populations, the urgency of upskilling essential workers (e.g., healthcare, logistics) during surges, and the necessity of delivering psychoeducational and social support when physical gathering is unsafe. Nevertheless, TEL in emergencies must be considered within complex ecosystems of infrastructure availability, power and connectivity reliability, literacy and digital skills, social norms (including gendered access), and protection risks; these contextual factors determine whether TEL augments resilience or amplifies harm. This paper aims to provide an evidence-informed synthesis of the promise and risks associated with TEL in humanitarian emergencies, to analyze intervention models that have been used for students and employees—drawing on COVID-19 and conflict-related case examples—and to propose pragmatic guidance for practitioners, donors, and policymakers including ethical safeguards and evaluation priorities.

2. LITERATURE REVIEW: PROMISE AND EVIDENCE BASE

The literature on TEL in emergencies spans policy guidance, implementation reports from humanitarian actors, and a growing but still limited empirical evidence base evaluating learning outcomes, reach, and cost-effectiveness. Policy documents from UNICEF, UNESCO, INEE, and the World Bank outline the theoretical benefits of TEL in emergencies: scalable dissemination, asynchronous access to content, personalization of pace through modular learning, and the capacity to collect programmatic data to inform adaptive management. Program evaluations from COVID-19 responses show that TEL maintained engagement for many learners when schools closed and enabled just-in-time workforce training, particularly in health sectors where e-learning modules and simulation videos supported rapid IPC (infection prevention and control) upskilling. Evidence also indicates that low-tech TEL (radio, SMS, recorded lessons) can achieve wide reach at low cost and is often more feasible in fragile contexts than synchronous online approaches. However, rigorous causal evidence on long-term learning gains, psychosocial outcomes, and labor-market impacts is uneven; randomized or quasi-experimental studies are relatively scarce due to operational constraints in crises. The literature consistently cautions that TEL does not uniformly deliver benefits and may entrench inequities if digital access, device ownership, and caregiver support are not addressed. Moreover, several case studies emphasize the critical role of facilitator support and community engagement in translating digital content into meaningful learning, suggesting that technology alone is insufficient without human-centered implementation.

3. METHODOLOGICAL AND ETHICAL CONSIDERATIONS FOR RESEARCH IN CRISES

Researching TEL interventions in humanitarian settings requires ethical sensitivity, methodological flexibility, and pragmatic trade-offs between rigor and feasibility. Standard impact evaluation designs may be impractical where populations are displaced, security is volatile, or longitudinal follow-up is infeasible; thus mixed-methods designs that combine rapid assessments, qualitative case studies, and adaptive monitoring are commonly recommended. Ethical considerations are paramount: data collection must minimize risk to participants who may be targeted if personal information is exposed, informed consent processes often require tailored approaches for minors and displaced populations, and research activities must not divert scarce resources from humanitarian priorities. Data protection frameworks and privacy-preserving methods should guide both program analytics and formal studies; anonymization, aggregation, and strict access controls are minimal standards in insecure environments. Researchers should also prioritize participatory methods that include community stakeholders in defining relevant outcomes, culturally appropriate metrics, and acceptable data use, thereby aligning research with protection and accountability principles. Finally, evaluation indicators should extend beyond access metrics to include learning quality proxies, psychosocial wellbeing, inclusion measures, and measures of workforce competency for employee training programs.

4. MODALITIES AND OPERATIONAL MODELS

TEL solutions in emergencies can be organized along a spectrum from low-tech to high-tech and from purely digital to blended human-technology systems. Low-tech modalities include radio broadcasting, IVR (interactive voice response), SMS-based micro-lessons, and printed packets augmented by phone or community facilitator check-ins; these modalities are resilient to infrastructure fragility and can reach low-literacy audiences when designed with audio-first or pictorial content. Mid-tech approaches use mobile phone apps with offline capabilities, preloaded content on devices distributed to learning centers, and local intranet solutions such as Raspberry Pi servers hosting LMSs accessible over Wi-Fi without internet backhaul; these solutions balance interactivity and offline resilience but require device management and power solutions. High-tech modalities comprise synchronous video classrooms, cloud-based LMS with analytics, and adaptive learning platforms that personalize pacing; these provide rich instructional affordances but depend on reliable connectivity and raise higher privacy and cost considerations. Blended models combine digital content with trained community facilitators or workplace mentors who contextualize and support learning, conduct formative assessments, and provide psychosocial support; evidence suggests that blended approaches often outperform purely digital or purely in-person alternatives in fragile contexts due to the essential role of human mediation. Operational models should be layered and redundant, with fallback low-tech channels, device charging and distribution plans, local content adaptation, and an explicit protection and data governance plan.

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Examples: Training Students — COVID-19 and Conflict Contexts

During the COVID-19 pandemic, many education systems rapidly deployed TEL at scale to maintain student learning. National radio and television lessons were widely used to cover curricular content, accompanied in some contexts by SMS prompts and teacher phone calls to support comprehension and monitor engagement. For example, several low-income countries implemented scheduled radio lessons aligned to grade-level outcomes, thought to be most effective when paired with printed materials and community volunteer support for individualized feedback; formative evidence indicates that such mixed delivery helped reduce learning loss relative to no-intervention scenarios, though gaps persisted, particularly for marginalized students. In conflict-affected contexts, TEL has been used to reach displaced learners via mobile phone-based literacy apps that function offline, community Wi-Fi hotspots with cached resources, and satellite-enabled connectivity for learning centers. Practical examples include preloaded tablets used by community facilitators to deliver modular accelerated learning programs for out-of-school children, with local mentors conducting in-person small-group sessions where security allowed. Across these student-focused examples, common success factors include localized content adaptation, integration of psychosocial and life-skills modules, community ownership and facilitation, and mechanisms for recognizing learning progress through portable credentials or teacher-verified portfolios that can follow learners across displacement.

Examples: Training Employees — Essential Services and Workforce Resilience

TEL has applied to workforce training in emergencies to rapidly upskill employees and volunteers in essential sectors such as health, utilities, logistics, and humanitarian operations. During COVID-19 surges, hospitals deployed microlearning modules—short, focused digital units on IPC, triage, and donning/doffing PPE—combined with video demonstrations and mobile assessments to certify competency quickly; these modules were effective when complemented by on-site simulation drills and supervisor mentoring. In conflict or disaster zones, employers and humanitarian agencies have used offline digital learning packages delivered on rugged devices to train maintenance crews, water and sanitation technicians, and supply chain staff; coupling these packages with mobile mentorship and locally based competency signoffs enabled continuity of operations when centralized training infrastructures collapsed. Private sector examples include remote onboarding and cross-training platforms that allowed small teams to cover critical functions during staff shortages, using task-based micro-credentials to validate readiness. These employee-focused TEL interventions highlight the importance of pragmatic competency assessments, employer buy-in for recognition of interim credentials, and psychosocial support for staff operating under stress. They also underline that workforce TEL must be aligned with safety protocols, regulatory standards, and contingency workforce planning.

5. RISKS, PROTECTION, AND EQUITY CONCERNS

Despite its promise, TEL poses serious risks in humanitarian settings that must be proactively managed. Digital divides manifest across gender, disability, socioeconomic status, and rural-urban lines; if TEL is deployed without deliberate inclusion strategies, it can widen educational inequities and entrench exclusion. Safety risks include exposure of personal data and location information that could be exploited in conflict settings, coercive use of surveillance-capable technologies by state or non-state actors, and the potential for misinformation to spread through poorly moderated channels. Dependence on digital platforms also generates operational fragility when power, devices, or connectivity are disrupted, and it can create hidden ongoing costs for learners and aid agencies (device maintenance, data costs). Pedagogically, poorly designed TEL risks prioritizing content delivery over interaction, assessment, and feedback, thereby reducing learning quality. Addressing these risks requires context-specific mitigation strategies: data minimization and encryption, transparent informed consent, gender- and disability-inclusive design, low-bandwidth content, offline-first applications, device-sharing protocols, backup low-tech channels, robust safeguarding and reporting mechanisms, and investment in facilitator capacity to humanize technology-mediated learning. Donors and implementers must also avoid technology fetishism and ensure investments are justified by needs assessments and locally led priorities.

6. DESIGN AND IMPLEMENTATION RECOMMENDATIONS

Responsible TEL deployment in emergencies should follow a layered, context-driven approach that places inclusion, protection, and sustainability at its core. First, conduct rapid context and needs analyses that map connectivity, device access, literacy, power availability, security risks, cultural norms, and labor market needs for workforce programs; use these findings to select modalities and set realistic targets. Second, prioritize layered modalities with low-tech fallbacks—radio

and printed materials should accompany digital content, and offline-capable apps or local servers should provide resilience against connectivity loss. Third, embed data protection by design: collect minimal personal data, apply encryption and access controls, and establish clear data-retention and deletion policies, ensuring transparency with communities about risks and uses. Fourth, invest in community facilitation and capacity building: technology should augment, not replace, trained facilitators and mentors who provide formative feedback and psychosocial support. Fifth, design inclusive content for girls, learners with disabilities, and marginalized groups through accessible formats, flexible schedules, and targeted outreach. Sixth, create pragmatic assessment and credentialing pathways such as employer-validated competency sign-offs, teacher-verified portfolios, or sector-recognized micro-credentials that function when formal systems are disrupted. Seventh, plan for sustainability and transition: TEL investments should align with long-term system strengthening, interoperability with national frameworks, and clear decommissioning or handover plans for devices and platforms. Finally, allocate resources to monitoring, evaluation, and adaptive learning processes to iteratively improve program quality.

7. RESEARCH AND POLICY AGENDA

To strengthen evidence and policy guidance for TEL in emergencies, prioritized research questions include: comparative effectiveness of layered TEL versus solely low-tech or high-tech approaches across diverse crisis contexts; long-term learning and labor-market impacts of TEL-augmented accelerated learning and workforce micro-credentials; cost-effectiveness analyses that incorporate hidden costs (maintenance, data, facilitator support); ethical frameworks and technical standards for data protection tailored to humanitarian settings; and scalable models for community-facilitated blended TEL that preserve local agency. Methodologically, investment in ethically designed longitudinal cohorts, realist evaluations, and participatory action research can produce actionable insights while respecting protection imperatives. Policy actions should focus on mainstreaming TEL contingency planning into national education and workforce resilience strategies, funding interoperable and open-source solutions to reduce vendor lock-in, supporting capacity building for local education authorities and employers, and creating multi-stakeholder coordination mechanisms that integrate protection, ICT, education, and labor sectors. Donors and governments should prioritize flexible financing that supports iterative adaptation and maintenance rather than one-off technology procurement.

8. CONCLUSION

Technology-enhanced learning offers substantive opportunities to sustain training for students and employees during humanitarian emergencies, enabling reach, rapid content adaptation, and continuity of services when traditional infrastructures are compromised. However, TEL is not a panacea; it entails risks that can exacerbate inequalities, compromise safety, and produce fragile dependencies if deployed without careful contextual analysis, inclusion measures, robust data protection, and community-led facilitation. The most promising TEL approaches in crises are layered and blended—combining low-tech resilience with digital affordances and human mediation—designed with explicit safeguards for protection and inclusion. Strengthening evidence through context-sensitive research, investing in local capacity, and aligning TEL with broader system resilience and accountability frameworks will be essential to harness TEL responsibly and effectively in future emergencies.

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