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DIGITAL TRANSFORMATION OF EDUCATION: INTERNATIONAL, EUROPEAN & NATIONAL REFORM FRAMEWORKS FOR REBUILDING SECONDARY EDUCATION IN UKRAINE

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Abstract

This article aims to analyse the multi-level policy architecture guiding the digital transformation of general secondary education in Ukraine as a strategic mechanism for educational reconstruction in the context of war-related disruption. The research employs a qualitative comparative policy analysis methodology, examining international (UNESCO, OECD, World Bank), European (EU Digital Education Action Plan 2021–2027, DigComp, DigCompEdu), and national reform frameworks (New Ukrainian School, National Recovery Plan, Digital Agenda Ukraine 2030). The methodological approach also integrates comparative case analysis of post-crisis digital education reforms in selected European countries. The findings reveal substantial

convergence between European and Ukrainian digital education strategies, particularly in teacher competence development, curriculum modernisation, and governance alignment. However, critical implementation gaps persist in digital infrastructure, connectivity equity, and national learning data governance. The study also identifies five strategic pillars—digital infrastructure, teacher competence, curriculum integration, learning analytics, and policy coherence—as essential foundations for systemic transformation. The conclusions emphasise that digital transformation should be understood not merely as technological modernisation but as a comprehensive reform framework essential for rebuilding a resilient, equitable, and future-ready secondary education system in Ukraine. Sustained multi-level governance coordination, targeted investment, and alignment with European digital competence frameworks are identified as decisive conditions for successful long-term educational recovery.

Keywords:

Digital Transformation, School Education, Ukraine Reconstruction, New Ukrainian School, EU Digital Education Action Plan, Digcomp, Digcompedu, Educational Policy, Hybrid Learning, Postwar Reform

1. Introduction. The Ukrainian Education Crisis: Scale and Urgency

The Russian Federation's full-scale invasion of Ukraine, launched in February 2022, precipitated one of the most severe educational crises in recent European history. More than 3,700 school buildings have been damaged or destroyed, approximately five million children have experienced serious disruption to their education, and over 700,000 Ukrainian students are now enrolled in educational institutions abroad (UNICEF Ukraine, 2023). The rapid, emergency shift to remote and hybrid learning modalities exposed pre-existing structural weaknesses in Ukraine's digital educational infrastructure — particularly the stark disparities between urban and rural connectivity, device availability, and teacher digital competence (Ministry of Education and Science of Ukraine, 2022).

Yet, within this unprecedented crisis lies a strategic opportunity. The imperative to rebuild Ukraine's general secondary education system from the ground up — or to radically transform what remains — aligns with a broader international and European momentum toward digital transformation in education (OECD, 2023; UNESCO, 2015). Ukraine's aspirations for

European Union membership further strengthen the case for aligning national educational reform with EU digital competence frameworks and policy directives (European Commission, 2021).

This article presents a systematic, multi-level analysis of the policy frameworks, reform instruments, and strategic recommendations relevant to the digital transformation of Ukrainian school education (Stoyka, 2024). It maps the architecture of international, European, and national reform initiatives, identifies convergences and implementation gaps, and proposes evidence-based recommendations for rebuilding a digitally resilient, equitable, and future-ready secondary education system. The scale of educational disruption caused by the armed conflict in Ukraine demands urgent systemic response (UNICEF Ukraine, 2023). The following dimensions define the crisis:

- **Infrastructure destruction:** Over 3,700 schools have been damaged or destroyed, with the highest concentrations in the Donetsk, Zaporizhzhia, Kharkiv, Mykolaiv, and Kherson regions (UNICEF Ukraine, 2023).
- **Student displacement:** Approximately 5 million children have experienced severe disruption; an estimated 700,000+ are currently enrolled in European host-country school systems (UNICEF Ukraine, 2023).
- **Emergency digitisation:** The sudden shift to emergency remote learning exposed profound digital divides — in broadband access, device ownership, and teacher readiness — particularly in rural and frontline communities (Ministry of Education and Science of Ukraine, 2022; World Bank, 2022).
- **Teacher crisis:** Mass displacement of educators, coupled with psychological trauma and professional burnout, has compounded structural staffing challenges (Stoyka, 2024).
- **Learning loss:** Cumulative educational deficit, particularly in mathematics, natural sciences, and critical literacy skills, threatens long-term human capital development (OECD, 2023).

These conditions make physical reconstruction alone insufficient. A digitally transformed educational ecosystem — one capable of delivering continuous, quality education regardless of physical location or security conditions — is not a luxury but a necessity (World Bank, 2022).

1.2 Digital Transformation as a Lever for Reconstruction

Digital transformation in education refers to the systemic integration of digital technologies, pedagogical innovation, and governance reform to fundamentally enhance learning outcomes, educational equity, and institutional resilience (European Commission, 2021; OECD, 2023). It is distinct from mere 'digitalisation' — the provision of devices or internet access — in that it encompasses cultural, organisational, and curricular transformation (European Commission, 2022a).

In the context of postwar reconstruction, digital transformation serves several intersecting strategic imperatives:

1.3 Educational Continuity

Hybrid and fully online learning environments allow schooling to continue even when physical infrastructure is unavailable or unsafe (World Bank, 2022). Properly designed digital ecosystems can serve students in bomb shelters, displacement centres, or host countries with comparable educational continuity to those in intact school buildings (UNICEF Ukraine, 2023; Ministry of Education and Science of Ukraine, 2022).

1.4 EU Accession Alignment

Ukraine's candidacy for European Union membership requires progressive alignment with EU standards across multiple sectors, including education (European Commission, 2021). The EU Digital Education Action Plan 2021–2027, DigComp 2.2, and DigCompEdu frameworks establish benchmarks for digital competence that Ukrainian educational institutions are expected to meet as part of the accession process (European Commission, 2021; European Commission, 2022a; European Commission, 2022b).

1.5 Labour Market Reconstruction

Postwar economic reconstruction will demand a workforce with advanced digital skills. Secondary education is the primary pipeline for developing these competencies (OECD, 2023). Curriculum reform aligned with 21st-century digital skills — coding, data literacy, digital communication, and critical evaluation of digital information — is therefore a strategic economic as well as educational priority (Ministry of Digital Transformation of Ukraine, 2021; European Commission, 2022a).

1.6 International Funding Conditionality

Major international donors and financing institutions — including the World Bank, the European Commission, and bilateral partners — increasingly condition education reconstruction funding on evidence of systemic reform implementation, including digital transformation

milestones (World Bank, 2022; European Commission, 2021). Compliance with these conditionalities is therefore an institutional imperative for Ukraine's Ministry of Education and Science (Ministry of Education and Science of Ukraine, 2022).

2. Multi-Level Policy Framework Architecture

The following table maps the principal international, European, and national policy frameworks and reform instruments that constitute the multi-level architecture of digital transformation in Ukrainian school education (European Commission, 2021; OECD, 2023; UNESCO, 2015; World Bank, 2022; Ministry of Education and Science of Ukraine, 2016, 2022; Ministry of Digital Transformation of Ukraine, 2021):

Table 1. *Key reform frameworks across international, European, and national levels relevant to digital transformation of Ukrainian school education (UNESCO, 2015; OECD, 2023; World Bank, 2022; European Commission, 2021, 2022a, 2022b; Ministry of Education and Science of Ukraine, 2016, 2022; Ministry of Digital Transformation of Ukraine, 2021).*

Level	Key Framework / Instrument	Core Mandate for Digital Education	Relevance to Ukraine Reconstruction
INTERNATIONAL	UNESCO Education 2030 / SDG 4	Inclusive, equitable quality education; digital inclusion as enabler	Benchmark for learning continuity indicators & equity targets
INTERNATIONAL	OECD Digital Education Outlook	AI integration, learning analytics, teacher digital proficiency	Evidence base for curriculum and assessment modernisation
INTERNATIONAL	World Bank EdTech Toolkit	Crisis-resilient hybrid models; device & connectivity equity	Infrastructure financing conditionality and impact metrics
EUROPEAN	EU Digital Education Action Plan 2021–2027	High-performing digital ecosystems; digital competences for all	Aligns Ukraine MoES strategy to EU accession requirements
EUROPEAN	DigComp 2.2 / DigCompEdu	Learner & educator digital competence frameworks (8 levels)	Foundation for national teacher certification & curriculum standards

Level	Key Framework / Instrument	Core Mandate for Digital Education	Relevance to Ukraine Reconstruction
EUROPEAN	Erasmus+ / Horizon Europe	Research, mobility, and cooperative innovation in EdTech	Funding mechanism for university–school digital pilot projects
NATIONAL	New Ukrainian School (NUS) Reform	Competence-based curriculum; learner agency & digital literacy	Core pedagogical transformation framework for grades 5–12
NATIONAL	Digital Agenda Ukraine 2030	National digitalisation roadmap; e-governance & digital skills	Cross-sectoral digital infrastructure planning affecting schools
NATIONAL	Ukraine National Recovery Plan (Education)	School reconstruction, hybrid learning hubs, teacher retraining	Priority investment pipeline aligned with EU Recovery Facility

2.1 Five Strategic Pillars of Digital Reconstruction

Analysis of the aforementioned frameworks, together with a comparative study of post-crisis digital education reforms in Estonia, Poland, and Georgia (Stoyka, 2024), yields five strategic pillars for digital reconstruction of Ukrainian school education:

Pillar I: Digital Infrastructure & Connectivity

Universal, reliable broadband connectivity and adequate device provision for all students and teachers constitute the foundational prerequisite of digital transformation (World Bank, 2022; European Commission, 2021). Currently, only approximately 41% of Ukrainian village schools have connectivity at or above 10 Mbps — a threshold widely considered the minimum for effective synchronous online learning (Ministry of Education and Science of Ukraine, 2022).

Pillar II: Teacher Digital Competence

Teachers are the primary agents of any pedagogical transformation (OECD, 2023; Stoyka, 2024). The DigCompEdu framework, which delineates six levels of educator digital competence across six domains (professional engagement, digital resources, teaching and learning, assessment, empowering learners, facilitating learners' digital competence), provides a robust and internationally recognised standard for teacher development (European Commission, 2022b). Its

systematic integration into pre-service and in-service teacher education in Ukraine is urgently needed (Ministry of Education and Science of Ukraine, 2022; Stoyka, 2024).

Pillar III: Digital Curriculum & Content

The New Ukrainian School reform has established a competence-based curricular framework for grades 1–12 (Ministry of Education and Science of Ukraine, 2016). However, digital competence strands — as defined by DigComp 2.2 (European Commission, 2022a) — have not yet been systematically integrated across all subject curricula for grades 5–12. This integration is essential for developing learner digital competence as a cross-curricular achievement rather than a standalone subject (European Commission, 2022a; Ministry of Education and Science of Ukraine, 2016).

Pillar IV: Learning Data & Assessment

Modern digital learning environments generate substantial data on learner progress, engagement, and outcomes (OECD, 2023). Ethical learning analytics — the systematic collection, analysis, and application of learner data to improve educational outcomes — requires both technical infrastructure and a robust governance framework (OECD, 2023; European Commission, 2021). Ukraine currently lacks a national learning analytics framework, creating data security vulnerabilities and limiting evidence-based policy-making (Ministry of Education and Science of Ukraine, 2022).

Pillar V: Governance & Policy Coherence

Effective digital transformation requires coherent multi-level governance — from the Ministry of Education and Science through regional administrations to individual schools (European Commission, 2021; Ministry of Education and Science of Ukraine, 2022). Fragmented policy implementation, siloed institutional responsibilities, and misaligned funding cycles undermine systemic reform (OECD, 2023; Stoyka, 2024). An integrated national digital education strategy, aligned with both EU frameworks and Ukraine's National Recovery Plan, is essential (Ministry of Education and Science of Ukraine, 2022; Ministry of Digital Transformation of Ukraine, 2021).

3. Key Findings

The multi-level policy analysis and comparative case study research (Stoyka, 2024) yielded the following principal findings:

- 63% of Ukrainian schools now operate in hybrid or fully online formats, demonstrating significant forced-pace digital adaptation since 2022 (Ministry of Education and Science of Ukraine, 2022).
- 28% of students in active conflict zones lack reliable access to a digital device, constituting the most acute equity challenge in digital transformation (UNICEF Ukraine, 2023).
- Three of the five strategic pillars — teacher digital competence, digital curriculum, and governance — demonstrate strong alignment between EU frameworks and Ukraine's national reform agenda (European Commission, 2021, 2022a, 2022b; Ministry of Education and Science of Ukraine, 2016, 2022). Infrastructure and learning data governance show the weakest alignment, representing the most urgent policy gaps (OECD, 2023).
- Approximately €1.4 billion has been pledged for education reconstruction within the Ukraine Facility framework, creating a significant but time-limited investment opportunity (European Commission, 2021).
- Comparative analysis of Estonia's post-Soviet digital education transition, Poland's emergency remote learning response, and Georgia's post-conflict school reconstruction provides actionable lessons for Ukraine's reform trajectory (Stoyka, 2024).

4. Implementation Gaps and Critical Barriers

Despite the significant reform momentum, several critical barriers impede effective digital transformation (OECD, 2023; Stoyka, 2024):

- **Platform fragmentation:** Ukraine lacks a unified, interoperable national Learning Management System (LMS). Multiple competing platforms — including Google Classroom, Microsoft Teams, and various national platforms — operate without integration, making portability of learner records across schools and regions effectively impossible (Ministry of Education and Science of Ukraine, 2022).
- **Teacher training deficit:** DigCompEdu is not yet embedded in either pre-service teacher education curricula or systematic in-service professional development programmes, resulting in widely variable and often inadequate levels of teacher digital competence (European Commission, 2022b; Stoyka, 2024).

- **Rural broadband gap:** The 41% connectivity rate in rural schools masks even lower rates in active conflict areas and temporarily occupied territories from which students are attempting to access education remotely (Ministry of Education and Science of Ukraine, 2022; UNICEF Ukraine, 2023).
- **Refugee digital exclusion:** Ukrainian students in European host countries face a compound exclusion — expected to participate in both Ukrainian digital schooling and host-country schooling simultaneously, often without adequate device or connectivity support in either system (UNICEF Ukraine, 2023).
- **Data governance vacuum:** The absence of a national learning analytics governance framework creates both data security risks and a significant barrier to evidence-based educational policy-making and international donor accountability (OECD, 2023; Ministry of Education and Science of Ukraine, 2022).
- **Donor cycle misalignment:** The predominantly short-term (12–36 month) project cycles of international education donors are structurally misaligned with the long-term (5–10 year) systemic reform timelines required for genuine digital transformation (World Bank, 2022; European Commission, 2021).

5. Policy Recommendations

On the basis of the multi-level analysis, comparative case studies (Stoyka, 2024), and expert consultation, the following six evidence-based policy recommendations are advanced:

01	Establish a National Digital Education Coordination Body — a dedicated inter-ministerial coordination mechanism linking the Ministry of Education and Science, the Ministry of Digital Transformation, and the EU Delegation — to ensure coherent, evidence-based governance of digital transformation reform across all levels of the education system (European Commission, 2021; Ministry of Education and Science of Ukraine, 2022).
02	Mandate DigCompEdu Level B1 (Integrator) as the minimum digital competence standard for teacher certification by 2027, with fully funded pre-service integration pathways and accessible in-service training programmes available to all practising teachers, including those in rural and frontline areas (European Commission, 2022b; Stoyka, 2024).

03	Deploy a unified, interoperable national Learning Management System compatible with EU platforms (including Moodle and the European Student Card Infrastructure), ensuring portability of learner records and continuity of educational access regardless of students' physical location — in Ukraine or abroad (European Commission, 2021; Ministry of Education and Science of Ukraine, 2022).
04	Prioritise satellite and mobile broadband connectivity solutions for frontline and rural schools within the National Recovery infrastructure plan, targeting a minimum of 25 Mbps connectivity for all schools by 2027, with priority for currently disconnected institutions in Donetsk, Zaporizhzhia, and Kherson regions (World Bank, 2022; Ministry of Education and Science of Ukraine, 2022).
05	Systematically integrate digital competence strands aligned with DigComp 2.2 progression levels (Foundation through Highly Specialised) into all subject curricula for grades 5–12 within the New Ukrainian School framework, ensuring that digital competence is developed as a cross-curricular achievement (European Commission, 2022a; Ministry of Education and Science of Ukraine, 2016).
06	Enact a comprehensive national learning data governance law, harmonised with EU General Data Protection Regulation (GDPR) requirements and the emerging EU AI Act obligations, prior to 2027 — establishing clear frameworks for ethical data collection, use, and protection in educational contexts (OECD, 2023; European Commission, 2021).

Conclusions

Digital transformation is not a parallel track to Ukraine's educational reconstruction — it is the reconstruction. The convergence of international SDG commitments, EU Digital Education Action Plan priorities, and Ukraine's New Ukrainian School reform creates a rare and time-critical window of multi-level policy alignment that must be strategically exploited. The analysis presented in this article demonstrates that the foundational conditions for successful digital transformation — a coherent policy architecture, international financial support, and strong

reform political will — are present. What remains urgently needed is the institutional capacity, inter-agency coordination, and long-term investment commitment to translate policy alignment into systemic change. With coherent multi-level governance, sustained investment, and genuine teacher empowerment, Ukraine has the opportunity to build one of Europe's most forward-looking and resilient secondary education systems from the ground up — turning an unprecedented crisis into a transformative opportunity for its children, its communities, and its future.

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