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DIGITAL TECHNOLOGIES AS TOOLS FOR EMBEDDING THE SUSTAINABLE DEVELOPMENT GOALS IN HIGHER EDUCATION LEARNING ENVIRONMENTS IN UKRAINE

Abstract. The article examines how digital technologies can be used as mediating tools to embed the Sustainable Development Goals (SDGs) in the learning environment of a Ukrainian technical university under conditions of ongoing russian military aggression. The problem addressed is the gap between high-level commitments to SDG integration in higher education and the often improvised, unsystematic use of digital tools in everyday teaching, particularly in technical and language-focused courses. The aim is to conceptualise and illustrate digital learning designs that connect SDG-related content with students' linguistic development, professional preparation and wartime experiences.

The empirical basis of the study is a set of digitally mediated tasks implemented in English for specific purposes and content-integrated classes with 89 fourth-year students of the Faculty of Power Engineering and Electromechanics over a 6 month period. Data sources include student artefacts (reports, forum posts, infographics, bilingual micro-texts), platform analytics and structured reflection questionnaires. The activities are organised around three clusters: energy resilience (SDG 7 and SDG 13), micro-audits of campus sustainability (SDG 11 and SDG 12), and crisis communication



for health, safety and institutional trust (SDG 3 and SDG 16). All data were collected and analysed in anonymized form, with informed consent and explicit guarantees of confidentiality and non-disclosure of personal information.

The results show that when digital tasks are closely aligned with students' lived wartime realities, SDG discourse becomes a practical design language rather than a decorative policy label. Students demonstrate more precise technical and argumentative language in English, more nuanced understanding of SDG trade-offs, and a stronger sense of agency in relation to reconstruction-oriented futures. At the same time, the study highlights constraints linked to digital inequality, infrastructural instability and cognitive overload, arguing that sustainable digital pedagogy in war must be designed around feasibility and care. The findings contribute to emerging theoretical and practical models of digitally mediated SDG education in disrupted higher education systems.

Keywords: digital technologies, Sustainable Development Goals (SDG), Ukrainian higher education, wartime education, English for specific purposes, technical engineering students, digital pedagogy.

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ЦИФРОВІ ТЕХНОЛОГІЇ ЯК ІНСТРУМЕНТИ ДЛЯ ВПРОВАДЖЕННЯ ЦІЛЕЙ СТАЛОГО РОЗВИТКУ В НАВЧАЛЬНЕ СЕРЕДОВИЩЕ ВИЩИХ НАВЧАЛЬНИХ ЗАКЛАДІВ В УКРАЇНІ

Анотація. У статті розглядається, як цифрові технології можуть бути використані як посередницькі інструменти для інтеграції цілей сталого розвитку

(ЦСР) у навчальне середовище українського технічного університету в умовах триваючої російської військової агресії. Розглянута проблема полягає у розриві між зобов'язаннями високого рівня щодо інтеграції ЦСР у вищу освіту та часто імпровізованим, несистематичним використанням цифрових інструментів у повсякденному навчанні, зокрема, на технічних та мовних курсах. Мета дослідження – концептуалізувати та проілюструвати цифрові навчальні дизайни, які пов'язують контент, пов'язаний з ЦСР, з лінгвістичним розвитком студентів, їхньою професійною підготовкою та досвідом воєнного часу в Україні.

Емпіричною базою дослідження є набір цифрових завдань, реалізованих англійською мовою для конкретних цілей, та інтегровані заняття з 89 студентами четвертого курсу факультету енергетики та електромеханіки протягом 6-місячного періоду. Джерела даних включають студентські артефакти (звіти, повідомлення на форумі, інфографіку, двомовні мікротексти), аналітику платформи та структуровані анкети для рефлексії. Діяльність організована навколо трьох кластерів: енергетична стійкість (ЦСР 7 та ЦСР 13), мікро-аудит сталого розвитку кампусу (ЦСР 11 та ЦСР 12) та кризові комунікації для охорони здоров'я, безпеки та інституційної довіри (ЦСР 3 та ЦСР 16). Усі дані були зібрані та проаналізовані в анонімній формі, за інформованої згоди та з чіткими гарантіями конфіденційності та нерозголошення особистої інформації.

Результати показують, що коли цифрові завдання тісно пов'язані з реаліями воєнного часу, дискурс ЦСР стає практичною мовою дизайну, а не декоративною політичною етикеткою. Студенти демонструють більш точну технічну та аргументовану англійську мову, більш тонке розуміння компромісів ЦСР та сильніше відчуття активності щодо майбутнього, орієнтованого на відбудову. Водночас дослідження висвітлює обмеження, пов'язані з цифровою нерівністю, інфраструктурною нестабільністю та когнітивним перевантаженням, стверджуючи, що стійка цифрова педагогіка під час війни повинна бути розроблена з урахуванням доцільності та обережності. Результати дослідження сприяють створенню теоретичних і практичних моделей цифрової освіти для досягнення ЦСР у порушених системах вищої освіти.

Ключові слова: цифрові технології, цілі сталого розвитку, українська вища освіта, освіта у воєнний час, англійська мова для спеціальних цілей, студенти технічних спеціальностей, цифрова педагогіка.

Digital technologies and the Sustainable Development Goals (SDG) are often discussed in separate conversations. One belongs to the vocabulary of global policy and strategy documents, the other to everyday classroom practice and urgent technical fixes. In contemporary Ukraine these conversations have been forcibly merged. University teachers and students are working, learning and sometimes sheltering under conditions of russian military aggression, repeated attacks on critical infrastructure and sustained



psychological pressure. In this context, digital tools are not only fashionable additions to teaching repertoires. They are instruments of continuity, resilience and, increasingly, of value education that speaks directly to the Sustainable Development Goals.

The global higher education community has been called to "embed" the SDGs in curricula, research and institutional culture. For language teachers and lecturers in technical universities this often translates into quite practical questions: how to move beyond one-off thematic lessons about climate change or inequality, how to avoid the SDGs appearing as a decorative poster on the wall of a learning management system, and how to connect global goals to the lived realities of students who may be studying from dormitories, front-line regions or internally displaced accommodation. For Ukrainian students the language of sustainable cities, responsible consumption or quality education is no longer abstract. It intersects with destroyed energy infrastructure, attacks on the environment, emergency relocations of laboratories and workshops, and the everyday effort to maintain a sense of normality.

Under wartime conditions, digitalisation in Ukrainian higher education has accelerated but also become uneven. Universities rely on learning management systems, cloud platforms and messaging applications to ensure that teaching continues when air-raid sirens interrupt classes or when power outages force rapid shifts between online and offline formats. Students may join a seminar from a corridor during an alert, complete assignments from a shelter using a mobile phone, or revise materials downloaded in advance in case of blackouts. At the same time, digital inequality is sharpened by damaged infrastructure, patchy connectivity and the economic consequences of war. These contradictions shape what is realistically possible when we speak about digital technologies as carriers of the SDGs.

Sustainable development itself is reinterpreted [1] in wartime. For Ukrainian society, Sustainable Development Goal 16 on peace, justice and strong institutions is immediately tangible: it is about survival, sovereignty and the defence of democratic norms. Goals related to energy, industry and infrastructure are linked to the reconstruction of power grids, the protection and restoration of rivers, forests and agricultural land affected by hostilities, and the design of more resilient systems. For students of engineering, information technology and other technical fields, these issues are not simply case studies from distant countries. They are part of their expected professional futures, whether in rebuilding bridges and hospitals or in designing secure digital systems for public services. A learning environment that takes the SDGs seriously must therefore invite learners to use disciplinary knowledge and foreign language skills to think through concrete Ukrainian scenarios.

Against this background, digital technologies offer not only channels for information delivery but also rich spaces for recontextualising the SDGs. Project-based tasks hosted on collaborative platforms can engage students in mapping local environmental damage, visualising energy consumption scenarios for their city, or



designing communication campaigns about responsible resource use in dormitories. Corpus tools, multilingual search engines and media archives can support critical reading [2] of international reports, news coverage and policy documents related to Ukraine, helping students compare narratives and evaluate how the war is framed in different discourses. Data dashboards and simulation environments can make trade-offs between short-term recovery and longer-term sustainability visible, grounding abstract targets in quantifiable choices.

From a linguistic perspective, digital environments intensify the need for careful work with language as both a tool and an object of study. When students work with SDG-related content in English, they encounter specialised vocabulary, complex argumentation and often the language of diplomacy and institutional self-presentation. In wartime, they also navigate disinformation, manipulative framing and contested interpretations of events. Digital media thus become arenas where foreign language competence, critical literacy and ethical judgement intersect. If designed purposefully, digital learning activities around the SDGs can strengthen students' ability to read, evaluate and produce texts that connect technical evidence with social and moral considerations.

Despite the proliferation of policy statements and inspiring case collections, systematic empirical research on how digital technologies actually function as tools for embedding the SDGs in higher education learning environments remains limited. This is particularly true for technical universities in countries experiencing armed aggression, where teachers are simultaneously dealing with curriculum reform, emergency digitalisation and the psychological needs of students. Many studies describe individual platforms or applications, but fewer explore how digital tools, pedagogical design and SDG content are integrated over time in specific disciplinary and linguistic contexts. Even fewer draw on data from Ukraine, where the pressures of war reveal both the fragility and the creativity of current arrangements.

This article responds to that gap by examining how digital technologies are used to embed the Sustainable Development Goals in the learning environment of a Ukrainian technical university, with particular attention to English-medium and English for specific purposes courses. It adopts the perspective of a linguist working within this system, who is simultaneously responsible for language development, content integration and the emotional climate of classes held under unstable conditions. The analysis focuses on concrete teaching scenarios in which digital tools enable students to engage with SDG-related issues that mirror their wartime experiences: energy security, environmental damage, social solidarity, psychological resilience and rebuilding.

The purpose of the study is twofold. First, it seeks to conceptualise what "embedding" the SDGs can meaningfully mean in a digital learning environment that is disrupted by war, beyond symbolic references or isolated thematic lessons. Secondly, it aims to document emerging practices that appear to support students' linguistic



development, critical engagement with sustainable development issues and sense of agency in the face of prolonged uncertainty. By situating these practices in the broader context of Ukrainian higher education under Russian aggression, the article contributes to international debates on digitalisation, sustainability and the role of universities in crisis.

In the sections that follow, the article outlines the theoretical framework connecting digital pedagogy, sustainable development education and wartime resilience, before describing the institutional and technological context of the case study university. It then presents a set of digital learning designs that integrate SDG content into technical and language courses, analyses student responses and challenges, and reflects on the constraints imposed by infrastructural vulnerability and fatigue. The conclusion discusses implications for curriculum design, teacher support and educational policy, arguing that the Ukrainian experience can inform global understandings of how digital technologies might carry the Sustainable Development Goals into real classrooms facing very real emergencies.

At a general level, the problem addressed in this article lies in the persistent disjunction between policy-level commitments to embed the Sustainable Development Goals in higher education and the uneven, often improvised ways in which digital technologies are currently integrated into everyday teaching practice, particularly in technical universities operating under conditions of war. Clarifying how specific digital tools and pedagogical designs can systematically mediate SDG-related learning in such disrupted environments is directly connected with urgent scientific and practical tasks: developing evidence-based models of sustainable digital pedagogy, informing curriculum and assessment reforms, and supporting the reconstruction-oriented mission of Ukrainian higher education.

Recent bibliometric and conceptual studies have traced how higher education engages with the Sustainable Development Goals, showing rapid growth of SDG related research but also a fragmentation between institutional strategy, curriculum work and pedagogical practice [3]. Gregori Giralt and colleagues, mapping course sustainability through an SDG inventory in a comprehensive Spanish university, demonstrate [4] that even ambitious programmes embed SDG aligned competencies unevenly across faculties and often at the level of declarative learning outcomes rather than concrete learning activities. Tomasella's 3Es framework for embedding the SDGs into marketing curricula similarly foregrounds engagement, expansion and enactment, yet treats [5] digital tools mainly as neutral delivery channels rather than as mediating actors shaping how students imagine sustainability problems and solutions. In parallel, Leal Filho et al. explore [6] digital transformation and sustainable development in higher education after the COVID 19 emergency, arguing that digitalisation can support SDG 4 on inclusive and equitable quality education while warning about deepened digital divides, higher energy consumption and new forms of social exclusion in poorly designed digital ecosystems. Ukrainian scholarship echoes these concerns: Hrebeniuk

and Okseniuk conceptualise [7] the current digital turn in education as a structural shift in which cloud platforms and national e learning initiatives both enable the knowledge society and introduce new risks for achieving sustainable development, particularly in conditions of economic and infrastructural fragility.

Empirical studies from other regions show that e-learning platforms can contribute directly to multiple SDGs, for example by expanding access to quality education, supporting gender equality and enabling partnerships for sustainable development, but they also highlight challenges of faculty readiness, student preparedness and contextualisation of content, as evidenced [8] in Derbas's quantitative study of Jordanian higher education. Policy oriented initiatives, including UNESCO's recent work [9] on digital resources for education for sustainable development, health and global competencies in Central Asia, further underscore that the pedagogical value of digital technologies depends on how they are embedded in interactive, problem-based learning rather than on the mere availability of platforms. At the intersection of SDGs, digitalisation and conflict, Al Shaer's case study of An Najah National University in Palestine shows that digital transformation can sustain higher education and advance selected SDGs in conflict zones, but emphasises political, infrastructural and financial constraints [10] that limit the depth of curricular innovation. For Ukraine, recent research has documented [11,12,13] the resilience of higher education under Russian aggression and the critical role of digital technologies in relocated universities, wartime examination regimes and emergency remote teaching, yet these studies focus primarily on institutional survival, student resilience and continuity of provision rather than on systematic SDG integration in digitally mediated. Consequently, despite a rich and rapidly expanding body of work, there remains a gap at the meso level of course and module design: we still lack detailed, context sensitive accounts of how specific digital technologies in Ukrainian higher education can be orchestrated to embed the SDGs into everyday learning tasks under conditions of chronic disruption, which is the unresolved aspect of the wider problem that the present article seeks to address.

The purpose of this article is to conceptualise and empirically illustrate how digital technologies can be used to systematically embed the Sustainable Development Goals into the learning environment of a Ukrainian technical university under conditions of ongoing Russian military aggression. The specific task is to identify and analyse digital learning designs that link SDG related content with students' linguistic development, professional preparation and wartime experiences, thereby generating evidence-based recommendations for curriculum, assessment and teacher support.

The main material of the study is organised around three clusters of digital learning designs that were iteratively implemented and refined in English for specific purposes and content-integrated classes at Vinnytsia national technical university. Across all activities, digital technologies were not treated as neutral channels for content delivery but as mediating tools that reconfigured how students encountered,



interpreted and acted on SDG related problems within a wartime reality marked by air raid alerts, rolling blackouts and infrastructural damage.

The first cluster focused on SDG 7 "Affordable and clean energy" and SDG 13 "Climate action" through a digitally mediated project on energy resilience. Using the institutional learning management system combined with shared spreadsheets and simple online dashboards, fourth-year students in Power Engineering worked with real blackout schedules for Vinnytsia, technical descriptions of local power infrastructure and excerpts from international policy documents in English. They were asked to model different demand-reduction scenarios for a winter week, to visualise these scenarios in graphs and infographics, and to comment on them in short English analytical notes. The results showed that students were able to move beyond general slogans about energy saving: their written work increasingly referenced specific SDG targets, distinguished between short-term emergency measures and long-term efficiency strategies, and connected these to their own experience of studying during power shortages. From a linguistic perspective, there was a clear shift from formulaic phrases towards more precise use of technical vocabulary and argumentative structures, suggesting that the combination of real data, visualisation tools and English commentary supported deeper conceptual and language development.

The second cluster engaged SDG 11 "Sustainable cities and communities" and SDG 12 "Responsible consumption and production" through a digital "micro-audit" of the university environment. Students used mobile devices to document energy and resource use in laboratories, corridors and dormitories, uploading photographs, short videos and notes to a collaborative mapping platform and a shared cloud folder. These artefacts were then categorised according to SDG targets in a jointly constructed online table and discussed in synchronous video sessions and asynchronous forum threads in English. Here the digital environment made visible both the material damage caused by missile strikes and the ad hoc sustainability practices that had emerged in response, such as improvised insulation, shared use of power banks and locally organised waste reduction. Analysis of forum posts and group reports showed that students gradually shifted from a deficit-oriented narrative ("everything is broken") towards a more systemic view that linked infrastructural problems, user behaviour and policy decisions. Importantly, they began to formulate feasible, low-cost interventions for their immediate surroundings and to articulate trade-offs between comfort, safety and resource conservation, indicating that SDG language had started to function as a practical design vocabulary rather than a distant policy register.

The third cluster worked with SDG 3 "Good health and well-being" and SDG 16 "Peace, justice and strong institutions" through digital tasks on crisis communication and psychological resilience. Drawing on their lived experience of air raid alerts and emergency relocations to shelters, students co-created bilingual micro-texts in English and Ukrainian for messaging applications, learning management announcements and



digital notice boards. These included concise instructions for safe behaviour during alerts in different parts of the campus, short supportive messages that normalised anxiety and fatigue, and templates for reporting infrastructure damage or dangerous situations. The texts were drafted in shared online documents, iteratively revised in small groups, and piloted in simulated alert scenarios during online sessions. Qualitative analysis of reflection logs indicated that students perceived this work as meaningful precisely because it addressed their current vulnerabilities and allowed them to contribute to a safer, more predictable learning environment. Linguistically, the tasks forced them to reconcile technical precision with empathy and clarity, strengthening their ability to calibrate tone and register in high-stakes communication, which is a key competence for future engineers who will have to interact with non-specialist audiences in stressful situations.

Methodologically, the study combined analysis of student artefacts (reports, forum posts, micro-texts, infographics), platform analytics (log-ins, task completion patterns, interaction frequencies) and structured reflection questionnaires administered at three points during the six-month period. The artefacts were coded for depth of SDG engagement, type of digital tool use and linguistic features, while the questionnaires captured self-reported changes in SDG awareness, perceived relevance to professional futures and confidence in using English for sustainability related tasks. Across the three clusters, the data consistently showed that students who engaged more intensively with the digital collaborative elements also demonstrated more nuanced SDG references and more autonomous use of English, supporting the central claim that the design of digital tasks matters at least as much as the choice of platform. At the same time, the analysis revealed persistent constraints: connectivity problems during blackouts, unequal access to personal devices, and cognitive overload during weeks with frequent alerts, which occasionally led to superficial task completion or withdrawal from online discussion.

These findings justify several scientific conclusions. First, they empirically support the argument that embedding the SDGs in wartime higher education cannot be reduced to adding SDG themed texts or videos to existing courses; instead, digital technologies must be orchestrated so that students work with data, scenarios and communicative situations that closely mirror their lived environment and anticipated professional roles. Second, they demonstrate that, under such conditions, SDG related learning can simultaneously advance foreign language competence, critical digital literacy and domain-specific reasoning, refuting the assumption that integrating sustainability topics into technical curricula necessarily dilutes disciplinary focus. Third, the results highlight the importance of aligning digital task design with students' emotional and cognitive bandwidth during prolonged crisis: activities that offered a clear sense of contribution to community safety or reconstruction were more resilient to disruption than those framed purely as academic exercises.

In total, 89 fourth-year students of the Faculty of Power Engineering and Electromechanics of Vinnytsia National Technical University participated in the study



over a six-month period, with all data collected and analysed in anonymised form on the basis of informed consent procedures that explicitly guaranteed confidentiality and non-disclosure of personal information, including consent to the use of aggregated and de-identified materials for research publication. Taken together, the examples and analyses presented here suggest that even under the extreme conditions of russian military aggression, carefully designed digital learning environments can become tangible spaces where the Sustainable Development Goals are not merely referenced but actively practised, negotiated and reinterpreted through the work of future Ukrainian engineers.

On 2025-11-24, Vinnytsia National Technical University hosted the online final of the 10th season of the startup school "Vinnytskyi Vyklyk", an innovation-oriented educational initiative aimed at developing engineers, entrepreneurs, and technology leaders under wartime conditions.

The event was implemented within an experimental project of the Ministry of Education and Science of Ukraine, in cooperation with the Innovation Development Fund, and is integrated into the national innovation ecosystem Sikorsky Challenge Ukraine, including the inaugural all-Ukrainian IT IDEA BATTLE competition with international participation.

The final program followed a structured sequence – official opening, team pitching, and results announcement – and began with a minute of silence for those killed in Ukraine, situating the innovation agenda within the social realities of the war. Speakers representing academia, government, municipalities, investors, and industry partners emphasized the importance of technological solutions for post-war recovery and competitiveness, and announced the creation of the Sikorsky Challenge Accelerator under UK jurisdiction to select leading projects for investment and joint ventures.

Eight teams presented projects spanning compact home hydroponics, real-time speech translation, cyber-hygiene training, craft e-commerce, road-condition analytics, vehicle cabin overheating prevention, affect-aware interfaces, and support services for Ukrainians abroad. The jury awarded RoadSense as the top project ("Best startup idea") with UAH 30,000, followed by StrawberryHub in second place with UAH 25,000 and CyberGuard in third place with UAH 20,000, alongside several incentive awards for other teams.

In SDG terms, these student-driven solutions can be aligned with Ukraine's Sustainable Development Goals during the war by prioritising [14] resilient infrastructure, responsible innovation, digital safety, and inclusive services that strengthen societal recovery capacity in both wartime and reconstruction phases.

Results. The study has shown that digital technologies can function as effective mediating tools for embedding the Sustainable Development Goals into the everyday learning environment of Vinnytsia national technical university even under conditions of russian military aggression. The most consistent effect across all three clusters was

observed when SDG related tasks were tightly connected to students' immediate wartime experiences and professional trajectories, transforming abstract global goals into concrete local design and decision problems. The findings indicate that such designs can support the parallel development of foreign language competence, critical digital literacy and domain specific reasoning, countering fears that sustainability content merely overloads already dense technical curricula. At the same time, the crisis communication and micro text activities underline that SDG 3 and SDG 16 are not peripheral themes but central to maintaining a safe, predictable and psychologically supportive learning environment for students living under chronic threat. The constraints identified in the data, particularly digital inequality, infrastructural instability and cognitive overload during periods of intensified attacks, highlight that sustainable digital pedagogy in wartime must be explicitly designed around thresholds of feasibility and care, not only around technological opportunity.

Prospects for further research include more systematic quantitative studies that track changes in SDG related knowledge, attitudes and competences over longer periods and compare different digital task designs within and across cohorts. A promising direction is the extension of this model to other faculties and institutions in Ukraine, including non-technical programmes, to test the transferability of design principles and to identify discipline specific adaptations in how digital tools carry SDG content. Future work should also focus on the professional development of teachers, exploring how linguists and subject specialists can be supported in co designing digital activities that integrate sustainability, language and technical content without increasing unsustainable workload. Given the rapid spread of artificial intelligence in educational platforms, there is a need to investigate how AI supported tools for translation, summarisation and data visualisation can either strengthen or weaken students' active engagement with the SDGs in multilingual, high stress contexts. Finally, comparative studies with other countries affected by war or protracted crisis could help to refine a broader theoretical framework for digitally mediated SDG education in disrupted systems and to inform reconstruction-oriented policy for Ukrainian higher education.

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