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STEM education in the post-war recovery model of Ukraine: comparison with the US experience

The article provides a comparative analysis of the development of STEM education in the USA and Ukraine in the context of post-war reconstruction. The legislative and financial support for STEM programs, mechanisms of public-private partnership, integration of education with industry and the defense sector are considered. The success of the implementation of STEM initiatives in key US industries – education, IT, defense, energy is assessed, and potential opportunities for adapting effective practices for the Ukrainian STEM education model are identified.

The results of the study show that in the USA, complex STEM ecosystems are being formed with large-scale budget funding (CHIPS and Science Act up to ~$280 billion by 2027; NSF up to ~$13 billion for STEM education), and the widespread use of grant programs. In Ukraine, STEM education is at the initial stage of development, funding is limited (~500 million UAH for school laboratories, ~1 billion UAH for university research centers), and there is no state strategy for integrating STEM with the economy and defense.

The analysis allowed us to outline key areas for the development of the national STEM ecosystem of Ukraine: legislative consolidation of priorities, large-scale financing, development of public-private partnerships, introduction of targeted STEM scholarships and integration of education with industry. The practical significance of the study lies in the formation of scientifically based recommendations for the development of a national STEM strategy of Ukraine, which will contribute to the training of highly qualified personnel, the restoration of the economy and the increase of the technological independence of the state.

***Keywords**: STEM education, post-war recovery, USA, Ukraine, national strategy.*

Introduction. Modern global transformations, driven by technological progress, geopolitical challenges and crisis phenomena, actualize the role of STEM education (Science, Technology, Engineering, Mathematics) as a key factor in the sustainable development of states, economic recovery and ensuring national security. In the 21st century, STEM education is considered not only as an educational paradigm, but also as a strategic tool for forming an innovative economy, developing human capital and increasing the global competitiveness of countries (Aguilera, Ortiz-Revilla, 2021; Batyuk 2025; Maiden, et al., 2025; Ausman, James, 2025).

The problem of developing STEM education acquires particular importance in the context of post-crisis and post-war recovery. The historical experience of leading states, in particular the United States of America, shows that targeted investments in STEM education and research activities are an effective mechanism for overcoming the consequences of large-scale crises, modernizing industry, developing defense technologies and ensuring technological leadership (Batyuk, 2025; Євтушенко, 2024; Кузьменко та ін., 2024; Петренко, Кокарєва, 2023; Янкавець, 2023; Балик, Шмигер, 2021; Buturlina, et al.,2021).

For Ukraine, which is in the process of post-war recovery, the issue of developing STEM education is becoming strategic. The destruction of educational and scientific infrastructure, the shortage of engineering and technical personnel, the need for rapid restoration of critical infrastructure, energy, the defense-industrial complex and the digital economy necessitate the formation of a comprehensive state policy in the field of STEM. At the same time, the modern Ukrainian system of STEM education is characterized by fragmented regulatory regulation, limited funding and insufficient integration with the real sector of the economy.

In this context, a comparative analysis of the approaches of the USA and Ukraine to the implementation of STEM programs, their financing mechanisms and institutional support acquires special scientific and practical importance. The experience of the USA, in particular within the framework of such large-scale initiatives as CHIPS and Science Act, the activities of the National Science Foundation and the system of public-private partnership, can serve as a guideline for the development of a national STEM strategy of Ukraine, taking into account its socio-economic and security realities.

Purpose and objectives of the study. The purpose of this study is to conduct a comparative analysis of STEM educational programs and budgetary mechanisms for their financing in the USA and Ukraine in order to determine the possibilities of adapting effective international practices to the Ukrainian model of post-war reconstruction. Achieving this goal involves analyzing educational, legislative and financial instruments to support STEM education, assessing priority areas of investment, and formulating recommendations for improving the state policy of Ukraine in the field of STEM.

Research objectives:

1. To analyze educational, legislative and regulatory documents of the USA and Ukraine on STEM education and innovation policy.
2. To identify key areas of budgetary financing of STEM programs in the USA and compare them with Ukrainian resources.
3. To assess the successes of STEM programs in the USA in education, IT, defense, and energy.
4. To identify the main problems of Ukrainian STEM education in the context of post-war reconstruction.
5. Formulate recommendations for adapting international experience for the Ukrainian STEM ecosystem.

Materials and methods of the study. The study employs a systematic and comparative approach that integrates educational, institutional, socio-pedagogical, and financial-economic analyses of STEM education in the United States and Ukraine. The research methodology includes the analysis of regulatory documents, such as U.S. legislative acts and national STEM policies, as well as educational standards adopted by the Ministry of Education and Science of Ukraine. In addition, a comparative analysis is conducted to examine STEM education systems, funding mechanisms, grant programs, and public–private partnerships. Statistical methods are used to analyze data on the number of STEM specialists and budget allocations. On successful initiatives such as programs of the National Science Foundation, including CAREER, and the SMART Scholarship Program, are study. The study also employs a synthesis method to integrate the collected data and outline recommendations and strategic pathways for improving STEM education.

Research results. A comparative analysis of STEM educational programs in the USA and Ukraine shows significant differences in approaches to organizing the educational environment and financing STEM education in the USA and Ukraine. In the USA, a systemic model of STEM support has been formed, which includes legislative prioritization (STEM Education Act, CHIPS and Science Act), multi-billion-dollar funding, public-private partnerships, and integration of education with the needs of industry, defense, and the digital sector. In Ukraine, STEM education is developing fragmentarily, within the framework of general educational and scientific programs. Funding is limited and distributed between universities and specialized schools without a separate legislative basis for STEM (see Table 1).

Table 1

Basic STEM programs in the USA and Ukraine

Category	USA STEM programs and budgets	Ukraine STEM programs and budgets
1	2	3
Legislative framework	STEM Education Act (2015), CHIPS and Science Act (2022)	Education Act, Ministry of Education and Science of Ukraine (MES) standards, STEM programs
Central agencies	NSF, Department of Education	Ministry of Education and Science of Ukraine
Total budget for STEM/science	CHIPS Act: ~$280 billion by 2027; NSF: ~$13 billion for STEM education	Education and science ~298.8 billion UAH (~$8.1 billion); for science ~20.1 billion UAH (~$540 million)
Support for universities	NSF CAREER Awards ($400 thousand for 5 years), R&D grants, SMART Scholarship ($30-40 thousand/year)	Research centers of excellence (~1 billion UAH), support for young scientists
Public-private partnership	Regional Innovation Engines, corporate grants (Google, Microsoft, Lockheed Martin)	First trials of Public-private partnership (PPP): 20 projects for 5 million UAH (Проєкт Закону про внесення змін до деяких законодавчих актів України, 2025; Державні сайти України, 2026)
Priority areas	IT, AI, cybersecurity, robotics, biotechnology, energy	Engineering, IT, energy, defense
STEM education in schools	MSP (Math & Science Partnerships), federal and local grants	Subsidies for STEM laboratories – UAH 499.4 million (~$13.5 million)
Workforce development	Large-scale training programs for the technology sector	Training of STEM personnel within university and college programs

Table 1 (Continued)

1	2	3
Support for universities and researchers	NSF CAREER Awards ($400,000/5 years), SMART Scholarship ($30–40,000/year), R&D grants	Centers of Excellence (~1 billion UAH), grants for young scientists
International support	NSF and DoD programs, grants from international funds	LEARN (World Bank, $415 million), UK-UA STEM PRO
Public STEM initiatives	FIRST Robotics, local science hubs	Da Vinci Ukraine, FIRST Tech Challenge Ukraine, Nova Ukraine

Among specific examples of US STEM programs and their successes, it is worth highlighting the NSF CAREER Awards program. Its goal is to support young scientists at the beginning of their careers. Funding is $400,000 for 5 years for scientific projects in STEM. The impact of this program in the educational environment is measured by more than 500 awards annually, the program stimulates innovative research and training in science, technology and education. For Ukraine, similar grants could stimulate the development of young research centers for post-war reconstruction (Faculty Early Career Development Program (CAREER), 2026).

The next well-known US STEM program is the SMART Scholarship Program (DoD). Its goal is to train engineers and researchers for the defense complex. The program is funded by scholarships of $30–40,000/year plus tuition coverage; guaranteed employment in the DoD. The impact of the program is to ensure a stable influx of highly qualified personnel in security-critical industries. For Ukraine, similar programs are state scholarships for students of technical specialties with mandatory participation in the restoration of critical infrastructure (Scholarship. Stipend. Internship. Career. Build Your Future With SMART, 2026).

Another well-known program is the CHIPS and Science Act (2022). The total budget is ~$280 billion by 2027. The goal of this US STEM program is to stimulate innovation, semiconductor production, support STEM education and R&D. Success consists of creating thousands of jobs, developing technology hubs, integrating education with industry. For Ukraine, a similar initiative could combine public, academic and private resources to restore industry and energy (Batyuk, 2025; CHIPS and Science, 2026).

Regional Innovation Engines program. The goal of this US STEM program is to develop local innovation hubs through PPP and university clusters. An example is the Massachusetts Green High Performance Computing Center, which brought together universities and IT companies to develop AI solutions. For Ukraine, such regional STEM hubs could accelerate local recovery and industrialization (Regional Innovation Engines. U.S. National Science Fondation, 2026).

Math and Science Partnerships (MSP) Program. The goal of this US STEM program is to improve STEM education in schools through grants to schools and universities. The results can be seen in an increase in student achievement in mathematics and natural sciences by 20–30% in 3 years. For Ukraine, adapting MSP approaches will allow modernizing school STEM education and preparing future engineers and IT specialists (Батюк, Жерновникова, 2025).

Among the Ukrainian budget programs, initiatives, and priority directions in STEM education, these examples can be identified:

1. Educational subvention for STEM equipment. In Ukraine, in 2025–2026, an educational subvention for STEM equipment is being implemented as part of the reform of the «Profilna» high school. A total of 499.4 million UAH was allocated to equip science and mathematics classrooms (biology, physics, chemistry, geography, mathematics) and STEM laboratories with modern equipment and technology for 108 schools throughout Ukraine. This subvention makes it possible to provide educational institutions with the tools necessary for the implementation of practical STEM classes, which is a basic element of preparing students for further technical and engineering specialties, and therefore a resource for forming future personnel for post-war reconstruction (STEM-субвенція, 2025.).

2. State funding of science and innovation. The draft State Budget for 2026 allocates UAH 7.3 billion for the development of science and innovation, which is almost three times more than in the previous year (Уряд передбачив 7,3 млрд грн на науку в проєкті Держбюджету-2026, 2025). These funds include:

– modernization of laboratories and equipment;
– support for researchers and young scientists;
– creation of Centers of Excellence (plan up to ~ UAH 1 billion) with modern space for training and R&D;
– implementation of public-private partnerships (PPP) in scientific projects (20 projects for UAH 5 million each);
– other forms of co-financing of science and business.

This provides a basis for the creation of interdisciplinary research clusters that can become local STEM hubs, similar to the American Regional Innovation Engines.

3. Projects with international support. In August 2024, the World Bank approved the LEARN education project with a volume of up to $415 million, aimed at supporting the education system of Ukraine. Part of these funds should be used to improve learning conditions, including subventions to local budgets for STEM educational activities (The World Bank, 2024). This scale of funding creates the potential for modernization of the educational infrastructure in the STEM field, which meets the needs of large-scale post-war reconstruction.

4. Grant STEM initiatives of public organizations. Non-profit organizations often play an active role in the development of STEM education. For example:

– Da Vinci Ukraine a grant program from the KSE Foundation with the support of the STEM Talent Fund, which allocates grants of up to $60,000 for the creation of STEM laboratories, conducting Olympiads, camps and trainings for students and teachers (Da Vinci Ukraine, 2026).

– FIRST Tech Challenge Ukraine a robotics competition (robots, 3D modeling, programming), held for the first time in Ukraine with financial support from the foundation and improving the practical training of schoolchildren (Ukraine to Host FIRST Tech Challenge Competition, 2026.).

– Nova Ukraine invests significant funds in the popularization of science through translations of popular science literature and conducting STEM classes and camps about $600,000 in 2023 with plans to double the contribution (Supporting STEM Education, 2026).

These initiatives contribute to the formation of an ecosystem of young talents and the creation of conditions for their involvement in the STEM segment, regardless of their place of residence or region.

5. Professional development and international programs.

The UK UA STEM PRO program, initiated by the Foundation of the President of Ukraine for the Support of Education, Science and Sports in partnership with British universities, is aimed at improving the skills of teachers and young scientists, developing projects in the university environment, and creating cooperation with business and international centers (UK-UA STEM PR, 2026).

This gives Ukrainian scientists access to modern international practices, commercialization of research results and development of R&D teams that can be used in post-war reconstruction processes.

Discussion of results. Studies have shown that the success of STEM programs in key US industries includes IT and the digital economy; NSF and CHIPS programs support AI, robotics, and cybersecurity. In Ukraine, the adaptation of similar programs will contribute to the development of the IT industry and the digital transformation of the post-war economy.

SMART Scholarship programs and DoD grants provide engineers for the defense complex. In Ukraine: similar scholarships can prepare personnel for the modernization of the defense industry. NSF and DOE programs stimulate the development of renewable energy and smart-grid technologies. In Ukraine: the implementation of similar grants will help modernize the energy sector and integrate green technologies into renewable projects.

According to the study, it was found that in the USA there is a clear consolidation of STEM priorities, including innovative grants and funding; in Ukraine there are basic educational standards, separate STEM sub-programs (Півень, Сударева, 2022; Пукальський, та ін., 2022; Вишківська та ін., 2024).

In the USA, agencies coordinate grants and workforce development; in Ukraine, administration is mainly through the Ministry of Education and Science.

Large-scale federal funding in the USA provides infrastructure development, research and training; in Ukraine, this is primarily limited funding, with a slow growth in invested funds. In the USA, programs provide a stable pipeline of STEM personnel; in Ukraine, these are start-up grants and laboratories. In the USA, Public-Private Enterprises (PPP) actively integrate education and research and development aimed at finding innovative solutions in the field of information technology R&D (Research and Development) and business; Ukraine is still at the initial stage. In the USA, MSP (Managed Service Provider), companies that provide comprehensive IT services on outsourcing from infrastructure support, software updates, backup to cybersecurity, increase student success by 20-30%; in Ukraine, modernization of classrooms and laboratories is currently underway. In Ukraine, programs provide access to international experience, translations, internships, support for practical STEM training, competitions, camps and projects for students. Areas where STEM education directly affects the economy and security: in the USA are direct employment through SMART-type programs, which includes adapting resumes to American standards, online interviews, receiving an official invitation (Job Offer) and visa sponsorship by the employer in such popular areas as software developers, medical workers (nurses), human resources managers and analysts; in Ukraine, STEM education is academic training and internships.

The analysis showed that in the coming years Ukraine can effectively adapt the following practices:

1. Legislative consolidation of STEM priorities, which will allow for targeted funding and integration of STEM education into economic and defense strategies.

2. Large-scale financing of STEM education and laboratories, including state grants for universities and schools.

3. Development of public-private partnerships, involvement of business in training, internships and financing of innovative projects.

4. Integration of education with R&D and industry, which will allow preparing the workforce for key industries: IT, defense, energy.

5. Implementation of targeted STEM scholarships and grants for students and young scientists, similar to the NSF CAREER Awards and SMART Scholarship.

Conclusions. The analysis showed that STEM education as a strategic resource for Ukraine's post-war recovery plays a key role in the formation of highly qualified personnel, modernization of critical infrastructure and development of an innovative economy. The US experience demonstrates that a systematic combination of legislation, budget financing and public-private partnership creates an effective STEM ecosystem capable of meeting the needs of the economy and defense even in times of crisis.

The US allocates large budgets for financial support for STEM education and programs, namely for STEM (CHIPS and Science Act – ~$280 billion, NSF – ~$13 billion), supports universities, young scientists and workforce development through grants and scholarships (NSF CAREER Awards, SMART Scholarship).

Ukraine, unlike the US, still has limited funding (~7.3 billion UAH for science and innovation, 499.4 million UAH for STEM laboratories) and fragmented programs. However, the growth of grant and international support (LEARN, UK-UA STEM PRO, Da Vinci Ukraine) creates potential for the development of the STEM ecosystem in the country.

Based on the experience of the United States, key areas have been identified where STEM education can have the greatest impact factor and acquire industry priorities for Ukraine, these are: 1) IT and digital technologies: modernization of laboratories, courses in AI and robotics; 2) Defense: training engineers for modernization of the defense complex; 3) Energy: introduction of renewable and "green" technologies; 4) Regional STEM hubs: local education and R&D centers for the restoration of post-war infrastructure.

Regarding the prospects for adapting international experience, Ukraine can adapt the following elements of the American model: legislative consolidation of STEM priorities; large-scale state and international funding; development of public-private partnerships; integration of education with industry, defense and R&D; targeted STEM scholarships and grants for students, teachers and young scientists.

The implementation of a comprehensive STEM strategy in the Ukrainian educational environment will contribute to socio-practical significance, namely: the formation of highly qualified personnel for critically important sectors; acceleration of the post-war recovery of the economy and industry; integration of Ukrainian science and education into the global STEM ecosystem; increasing the innovative potential and technological independence of the state.

The prospects of our further research include the following steps: analysis and consideration of the national STEM strategy; assessment of the effectiveness of educational public-private partnerships in STEM; integration of international standards and grant practices into the national education system; analysis of the creation of regional STEM hubs as a mechanism for post-war recovery and development of the local educational ecosystem.

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STEM-освіта у моделі повоєнного відновлення України: порівняння з досвідом США

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У статті здійснено порівняльний аналіз розвитку STEM-освіти у США та Україні в контексті повоєнного відновлення. Розглянуто законодавче та фінансове забезпечення STEM-програм, механізми державно-приватного партнерства, інтеграцію освіти з промисловістю та оборонним сектором. Проведено оцінку успішності реалізації STEM-ініціатив у ключових галузях США – освіта, IT, оборона, енергетика, та виявлено потенційні можливості адаптації ефективних практик для української моделі STEM-освіти.

Результати дослідження показують, що в США формуються комплексні STEM-екосистеми із масштабним бюджетним фінансуванням (CHIPS та Science Act до ~$280 млрд до 2027 року; NSF до ~$13 млрд на STEM-освіту), широким застосуванням грантових програм. В Україні STEM-освіта перебуває на початковому етапі розвитку, фінансування обмежене (~500 млн грн на шкільні лабораторії, ~1 млрд грн на університетські дослідницькі центри), а державна стратегія інтеграції STEM з економікою та обороною відсутня.

Аналіз дозволив окреслити ключові напрямки для розвитку національної STEM-екосистеми України: законодавче закріплення пріоритетів, масштабне фінансування, розвиток державно-приватного партнерства, запровадження цільових STEM-стипендій та інтеграція освіти з промисловістю. Практичне значення дослідження полягає у формуванні науково-обґрунтованих рекомендацій для розробки національної STEM-стратегії України, яка сприятиме підготовці висококваліфікованих кадрів, відновленню економіки та підвищенню технологічної незалежності держави.

Ключові слова: *STEM-освіта, післявоєнне відновлення, США, Україна, національна стратегія.*

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