

EDITORIAL

Science in postwar Ukraine

Next month will mark 1 year since Russia escalated its war on Ukraine. The senseless casualties and destruction have been met with stunning resilience by Ukraine and international opposition to Russia. Although the war continues, there is hope that Ukraine will emerge as an open and free democracy, which would include rebuilding its scientific enterprise with new infrastructure and laws.

Transforming the scientific system in Ukraine, which includes education, research, and technological development, began after the country gained independence in 1991. Although progress in moving away from research agendas and programs dictated by the Soviet Union has been slow and inefficient, the unprovoked war that started in 2014 stoked the destruction of educational and scientific institutions by Russian troops. Escalation to full-scale war in 2022 has destroyed at least 15% of Ukraine's research infrastructure, including an atomic physics laboratory and Karazin National University in Kharkiv, a chemical laboratory at Chernobyl, and the Ministry of Education and Science of Ukraine in Kyiv. The damage has created economic and political rifts that have affected research in physics, space science, climate, food security, and energy on a global scale. This includes international projects such as ExoMars and Arctic PASSION, which have stimulated discussions about how to best restructure global scientific cooperation models.

The European Union will help assess the physical damage to scientific and educational infrastructure. However, damage to human capital will be more difficult to evaluate. More than 200,000 students and scientists have left the country and may never return unless post-war Ukraine shows signs of new potential.

Should the end of the war create an opportunity to leapfrog the existing Ukrainian scientific system, what could the new structure look like and how might it be achieved? Ideally, there should be a new funding system to attract the best scientists and personnel. The money for this would come from frozen €19 billion of assets belonging to Russian oligarchs and €300 billion of Russian Central Bank reserves that are blocked in the European Union and other G7 partners. Another improvement would be to consolidate the state-owned higher education network that operates according to

a decentralized management model in which each administrative region has at least one public traditional and one public technical research university. This would be supported by regional hybrid financial mechanisms involving state budget and local business in partnership. National academies could maintain the status of nonprofit professional organizations with a focus on scholarly publishing and providing high-level expertise to public and private organizations. Another strategy would be to establish institutions that focus on fundamental research and those that support applied research and production. Here, the government could be guided by recommendations of the Organization for Economic Cooperation and Development (called the Frascati guidelines) to construct, fund, and monitor complex research and development programs.

In 2018, Ukraine's Ministry of Education and Science established the New Ukrainian School, a reform of primary school in which students gained knowledge and skills through more practical activity and engagement with teachers and others. The success of this program suggested a continuation of this approach at the next levels of education. This will require new training for teachers and new curricula.

The world's scientific and educational community has formed ad hoc groups to help save Ukrainian scientists that have left the country. In September 2022, an international workshop (Rebuilding Research, Education and Innovation in Ukraine) organized by the US National Academy of Sciences, Engineering, and Medicine recognized that the future of Ukrainian science must be based on global research networks, paired with global higher education systems and training programs for decision-makers and scientific managers. Other international efforts committed to rebuilding Ukrainian science include the European Commission, which is working on a plan to help Ukraine prepare for its eventual reconstruction.

It will be a challenge to bring people back to Ukraine to rebuild. Hopefully, those elected to lead Ukraine will understand that supporting education and science is not an unnecessary cost, but rather an invaluable investment in human capital and the future of the country. But the war must end first.

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