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Opinion Article

For Developing Countries, Science Begins with Scarcity

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Opinión

Doing science in developing countries is not a luxury but an act of resistance. While research centers in wealthier nations have access to cutting-edge technology and multimillion-dollar funding, many researchers in the Global South must rely on creativity to make progress with minimal resources. Rather than being an absolute limitation, this reality has fostered a more resilient, pragmatic, and deeply innovative approach to science.

In Latin America, Africa, and Southeast Asia, the scarcity of funding, infrastructure, and trained personnel is a constant challenge throughout the entire educational process, from primary school to higher education. The lack of resources affects the training of researchers and impacts the quality of education at all levels, creating knowledge gaps that are difficult to bridge. In this context, a widely used strategy among educators is problem-based learning with limited resources, fostering creativity and adaptability from an early stage. Despite these challenges, science conducted in resource-constrained settings has produced relevant solutions tailored to local needs—often more efficient than those developed in countries with more significant funding. Reusing outdated equipment, working with accessible materials, and interdisciplinary collaboration have become essential strategies for sustaining research. However, the lack of recognition for these efforts and the tendency of high-impact journals to favor studies from well-funded countries hinder their visibility in the global scientific community. The problem extends beyond knowledge production to its publication and dissemination. Strengthening support for scientific publications is crucial to breaking this cycle of exclusion and giving greater exposure to science emerging from scarcity.

The lack of resources has led many researchers to break down disciplinary barriers. Integrating knowledge from engineering, biomedicine, physics, and chemistry has enabled the development of low-cost technologies with direct applications in public health, food production, and water treatment. Examples such as the development of accessible medical sensors, water purification systems using nanomaterials, and innovative therapies based on natural products demonstrate that interdisciplinary science is a necessity rather than a choice in these contexts. In countries where laboratory equipment may take years to acquire, adaptability and the ability to innovate with limited tools become crucial assets for scientific progress. Unlike traditional scientific models, where researchers specialize in highly segmented fields, collaboration across disciplines is required for success in developing countries. Without access to hyperspecialized laboratories, scientists must find joint solutions with experts from various fields, generating a more holistic approach to problems. This model has proven particularly useful in public health, where the lack of hospital infrastructure and adequate medical equipment has driven the implementation of innovative strategies for diagnosing and treating diseases. The development of low-cost diagnostic tests for neglected diseases, the use of artificial intelligence to diagnose conditions in rural communities without access to specialized doctors, and the implementation of telemedicine programs have emerged as concrete responses to the challenges faced in these regions.

One of the most remarkable contributions of science in contexts of scarcity is its focus on applicability. Rather than pursuing discoveries with a purely theoretical approach, research in developing countries often responds to urgent needs such as neglected diseases, lack of access to clean water, sustainable agricultural methods, and affordable energy solutions. Creativity emerges as the most valuable resource in this process. Some notable cases are the development of neonatal incubators made from recycled parts, the use of agricultural waste to produce bioplastics, and the implementation of artificial intelligence in low-cost medical diagnostics, illustrate how science can advance without relying on exorbitant budgets. These innovations often outperform conventional solutions and can be rapidly implemented in communities with pressing needs.

Despite their impact, scientific efforts in developing countries face significant barriers to global recognition. Limited access to high-impact journals, underrepresentation in international conferences, and dependence on external funding restrict the visibility of these advancements. Moreover, many scientific evaluation models are designed for contexts of abundance without considering structural differences between regions. Researchers in developing countries often face a double challenge: producing science with limited resources and then struggling for its legitimization in a system that does not recognize their reality. This creates a cycle of exclusion, where scientific efforts from these regions are relegated to low-impact publications or even total invisibility.

In recent years, global socioeconomic and political dynamics have widened the gap between those accessing advanced technology and those relying on limited tools. The global supply crisis, export restrictions on scientific equipment, and the dependence of developing countries on major powers for technology acquisition have highlighted the vulnerability of science in fragile economies. Economic sanctions, inflation in the cost of essential components, and the monopolization of knowledge have forced researchers to seek alternatives that do not depend on foreign suppliers. In this sense, it is urgent to rethink how scientific production is conceived: we can no longer rely solely on importing state-of-the-art equipment but must invest in locally manufactured technology and develop in-house capabilities to build scientific instruments.

Technological self-sufficiency is not just an aspiration but an urgent necessity. Several countries in Latin America and Africa have launched initiatives to manufacture microscopes, 3D printers, spectrometers, and other equipment using recycled materials or low-cost components. These efforts have reduced dependence on international markets and opened the possibility of expanding research in universities and centers that previously lacked adequate equipment. Investing in training engineers, physicists, and technicians with the skills to design and manufacture laboratory equipment is a key strategy for strengthening scientific autonomy. If we do not build our tools, we will remain at the mercy of global dynamics that marginalize low-income countries and perpetuate knowledge inequality.

It is crucial to rethink how scientific quality is measured, including indicators that recognize innovation based on limited resources. Strengthening collaboration networks among countries with similar conditions can be key to building a more equitable global scientific community. International cooperation should not be limited to technology transfer from developed to developing countries but should also include recognizing local knowledge as a valid source of innovation. This involves fostering scientific publications with more inclusive approaches, facilitating access to competitive funding, and redefining impact metrics to acknowledge science that addresses real-world needs beyond citation volume or journal impact factors.

Doing science in developing countries is not simply about replicating the models of wealthy nations with less money. It is a different way of thinking, innovating, and solving problems with the resources at hand. In these contexts, scarcity is not a death sentence for research but the starting point for a more agile, interdisciplinary, and socially connected science. The key lies in recognizing and valuing these efforts and understanding that true innovation often arises from necessity rather than abundance. If we want to move towards a more equitable global scientific landscape, we must stop depending on foreign technology and start building our scientific and technological capacity.