What are the basic sciences and why does ISP support them?

The International Science Programme (ISP) at Uppsala University has a focus on basic sciences. But how are those defined, and what is the justification for supporting basic sciences in developing countries? What is ISP's approach? Will support to basic sciences contribute to poverty reduction?

Definition of the basic sciences

The basic sciences are defined as the scientific disciplines of mathematics, physics, chemistry, and biology. They are denoted basic sciences because they provide "a fundamental understanding of natural phenomena and the processes by which natural resources are transformed".[1]

Basic sciences research is sometimes confused with fundamental research. Garret & Granqvist (1998) make the following distinction: "Within science, the terms basic and applied have double meanings. The basic sciences are generally defined as mathematics, physics, chemistry and biology. They are often given in this order (...) to reflect their natural relationship to each other. (...) Confusion can arise because research in any science, basic or applied, can be either fundamental or problem oriented. (...) So sciences are either basic or applied, and the research carried out in either sort can be either fundamental (basic) or problem oriented (applied)."

ISP *defines basic science as the disciplines of science that encompasses mathematics, physics, chemistry and biology – not distinguishing whether the research is fundamental or applied*. Fundamental research within the basic sciences creates new knowledge, independent of possible, future applications, and provides fundamental, basic understanding of nature. Applied, research uses and elaborates on results emerging from fundamental research within the basic sciences. *Basic sciences constitute a cornerstone of societies and a cradle for innovation and welfare development.*

General justification for supporting the basic sciences in developing countries

Professor Bo Sundqvist, former Vice-Chancellor of Uppsala University, has emphasized the importance of the basic sciences: "The cornerstone for knowledge-based economies is the systematically developed foundation of basic knowledge that leads to technological development. Today, and even more so tomorrow, new technologies like biotechnology, materials technology, and information and communication technology are rooted in basic knowledge." (Lindqvist, 2001).

In the evaluation of ISP's operation 2003-2010, seven reasons are given why aid money should be used to support "enabling" sciences (GHD 2011).[2]

1) Most of the flagship breakthroughs in development that disproportionately benefit the poor have science at their core.
2) Research in the enabling sciences is a "public good", and often a global public good.
3) Expenditure on Research and Development, including the enabling sciences is low, both by developing country governments and their development partners. Indeed, the World Bank finds that the gap between Research and Development spending between rich and poor countries is much larger than the income gap between those countries.
4) Market forces are such that OECD research institutes, and companies, rarely invest in research of direct interest to developing countries.

[1] International Conference on Donor Support to Development-Oriented Research in Basic Sciences, 15-16 June 1995, Uppsala, Sweden: Declaration and Recommendations for Action.

[2] GHD (2011) point out that "*The term "basic science" is often used to describe* [chemistry, physics and mathematics] *and similar disciplines (biology for example). This evaluation report adopts the descriptor "enabling sciences" to send a clear reminder of the role of these disciplines, and also to avoid potential confusion arising from the basic/applied dichotomy."*

5) Enabling science underpins productivity and international competitiveness: key drivers of sustainable economic growth in a globalised world. Enabling science is a necessary (although not sufficient) condition for technological improvement and productivity increases in agriculture (crops and livestock) manufacturing (power generation and telecommunications) and the service industries (health sciences).
6) Enabling science provides the evidence base for responding to many of the most basic challenges facing developing countries, be they low-income or middle-income. These challenges include responding to climate change […] and public health […].
7) Research and training needs long term investments. None of the breakthrough discoveries have been achieved without long term, predictable, sustained financing.

On a similar note, the empowering role of scientific knowledge is highlighted in the report from the evaluation of ISP 2014-2018 (Pain *et al*., 2018): “In the increasingly dominant view of the instrumental value of higher education, and the role of science and technology in particular in contributing to economic development, the public good role of higher education should not be neglected. This speaks to the intrinsic merits of scientific knowledge and the empowering aspects of that knowledge […].”

The importance of basic sciences is also emphasized by UNESCO (2015), stating that "we should not forget that basic science and applied science are two sides of the same coin" and that they are "interconnected and interdependent [and], thus, complement each other in providing innovative solutions to the challenges humanity faces on the pathway to sustainable development. An adequate investment in both basic sciences and applied research and development will be critical to reaching the goals of Agenda 2030."

Considering Africa, where ISP has its current focus, the GHD (2011) report concludes that “science makes a unique and essential contribution to the development process, yet is underfunded and underutilised in Africa.” Furthermore, it is observed that “The Africa Union Commission’s Consolidated Plan of Action for Africa’s Science and Technology acknowledges the importance of addressing these issues so that Africa can harness and apply science, and contribute to the global pool of knowledge. Africa is, however, under-investing in science and has a disproportionately low number of scientific publications and patents. It clearly has a need for more scientific input into decision making and scientific outputs.”

The global perspective was also raised at the annual board meeting of ISP in December 2019, where the board expressed the view that capacity in basic sciences empowers countries to address their own challenges and find their own solutions, relevant to their situation (local solutions to local challenges). This, in fact, also enriches the global body of knowledge with a greater diversity of perspectives. It was also re-emphasized that well-developed, sustainable capacity in basic sciences is a necessity for development and a driving force for innovation – but to realise this, external support is currently required.

Here, the board observed that a particular challenge in developing countries is that, given their very limited government resources, basic sciences will often not be a priority over meeting more fundamental needs. Therefore, external funding is still critical for developing basic sciences capacity in resource-challenged settings. However, this funding should be provided with the aim to make it catalytic towards a domestic ability to sustainably fund such research over time. In the long perspective, governments need to ramp up their support to science via domestic resource mobilization, increasing their control over the research agenda and decreasing donor dependency.

Does support to basic sciences contribute to poverty reduction?

The link between support to research capacity and higher education in the basic sciences, on the one hand, and poverty alleviation, on the other, cannot be expected to be direct and short-term. However, as stated by GHD (2011), “Good enabling science is a necessary condition for development

and poverty alleviation. Other factors not within the domain of good science must also be in place for the optimal benefit to be captured." (Elaborated in detail in Annex C to the evaluation report)

A World Bank (1998) study of 55 developing countries finds that "there is a significant and positive association between the prevalence of science, maths, and engineering graduates and per capita GNI."

ISP support to basic sciences in developing countries

ISP was founded in 1961, and has for almost 60 years of operation established a successful model for strengthening the capacity in the basic sciences mathematics, physics and chemistry in primarily "low and lower middle-income countries".[3] The model applies long-term collaborative support to institutionally based research groups and scientific networks, aiming at strengthening institutional research capacity, producing and disseminating high-quality research results, and training staff member to PhD level by adopting the so called "sandwich" approach as described by Andersson (2017).[4] The success rate of ISP is exemplified by a study carried out in 2016 which showed that 94% of previously ISP-supported research groups[5] were still pursuing research and PhD training (Andersson & Sundin, 2017). Many of these groups are located in countries where universities and governments are now increasingly allocating common resources to education, such as Thailand (Andersson & Zdravkovic, 2017). Moreover, close to 95% of PhD graduates from of ISP-supported activities remain in their countries and regions, where they continue contributing to development,

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[3] https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups

[4] According to Lindqvist (2001), a first concept of the sandwich PhD training model was outlined in 1967. (http://uu.diva-portal.org/smash/get/diva2:331705/FULLTEXT01.pdf)

[5] ISP terminated support to 49 research groups in the time span 2003-2014, 46 were still active 2016. (https://www.isp.uu.se/digitalAssets/504/c_504316-l_1-k_phased-out-groups-and-networksfinal.pdf)

[6] http://www.unesco.org/new/en/media-services/single-view/news/what_is_the_optimal_balance_between_basic_and_applied_research (accessed 17 October 2019)

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